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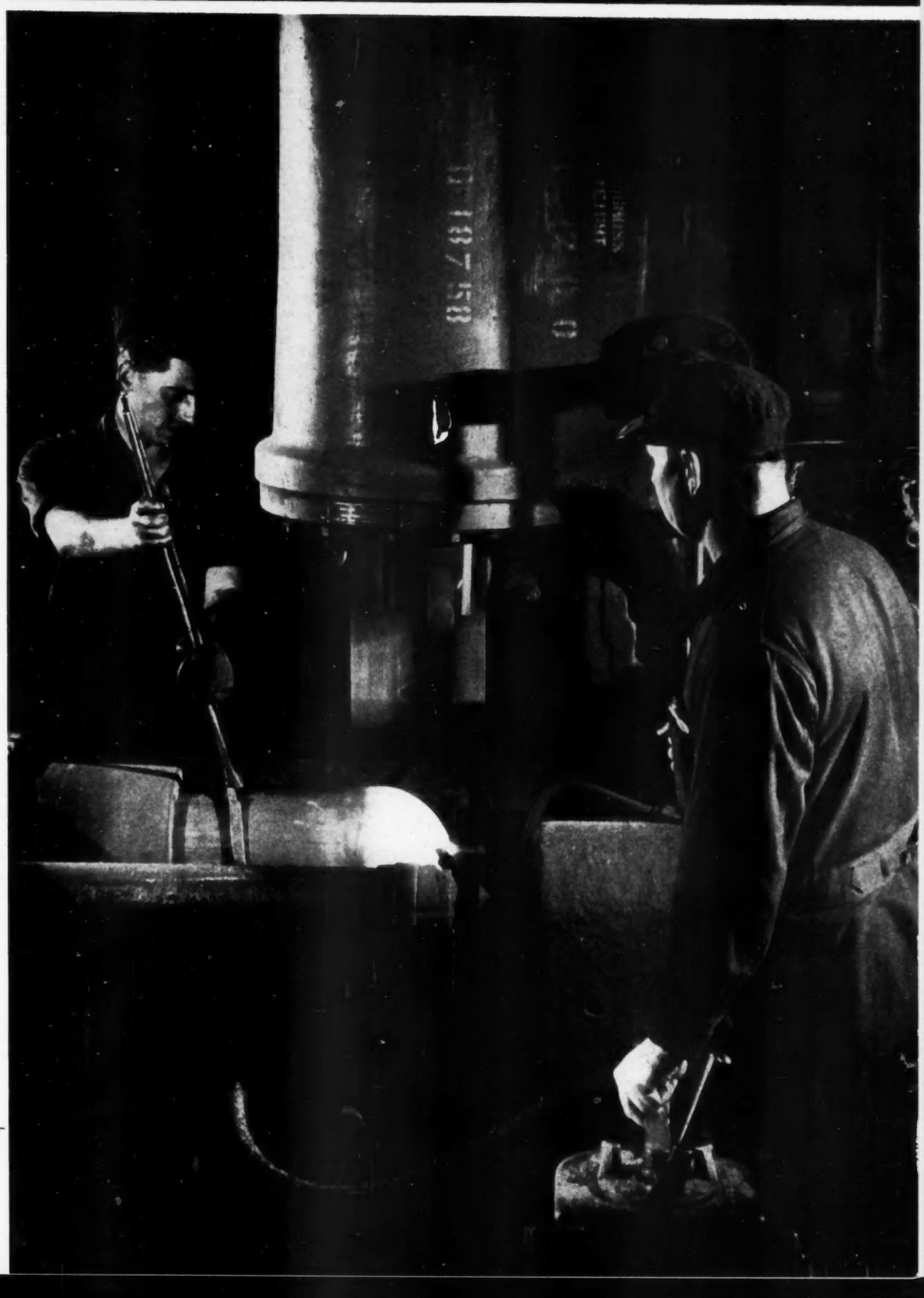

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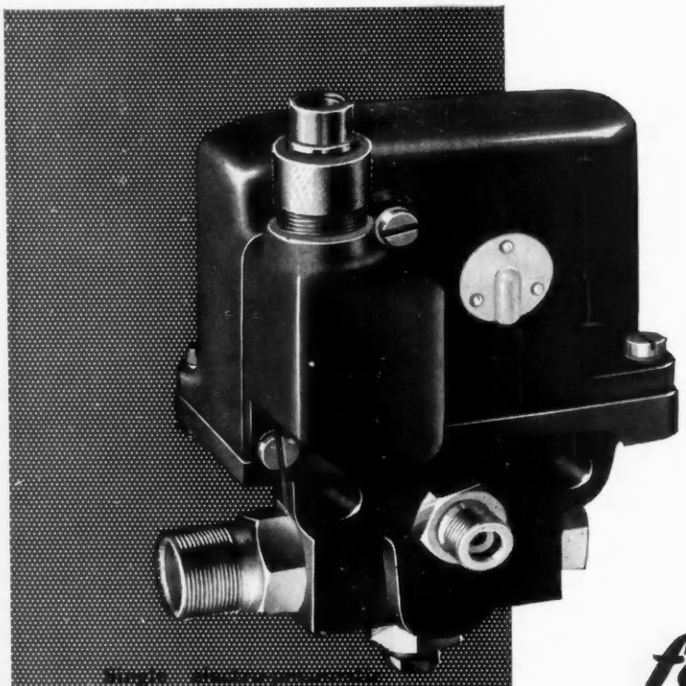

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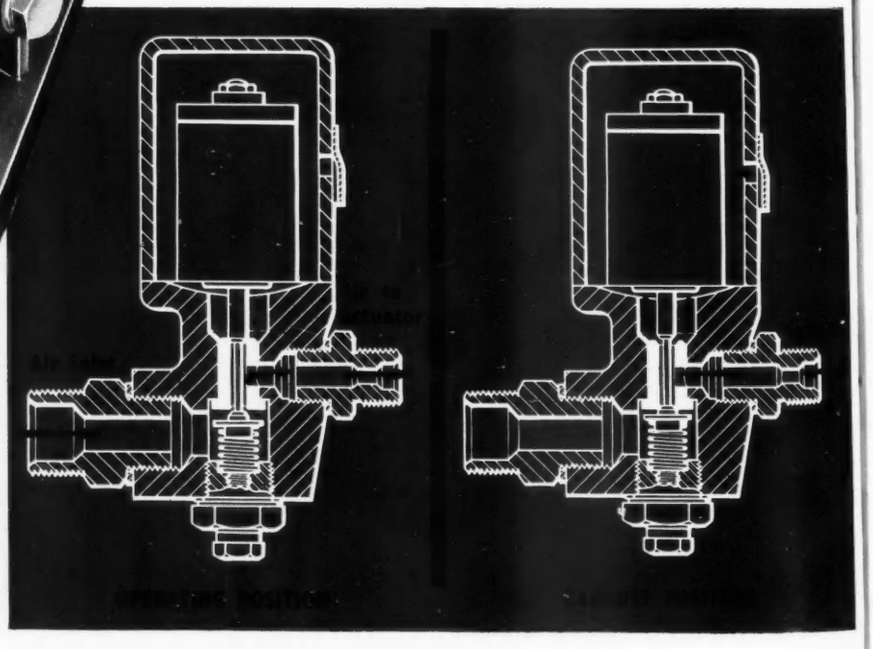

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ENGINEERING

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Contents

65 **Leading Article**
Since the War

66 **Plain Words**

67 **Letters to the Editor**
Counting with the Fingers
"Wharton" Universal Jig and Fixture System
Strain Hardening of Cylinders

72 **Companies in the News**

73 **Atomic Review**
Part and Parcel

75 **In Parliament**

76 **Special Article**
For a Five-Year Boom: Western Europe Owes it to Engineering

90 **Trade Publications**

91 **Book Reviews**
Proceedings of the Second Symposium on Concrete Shell Roof Construction. 1-3 July 1957
Reinforced Concrete in Architecture

91 **New Books**

91 **On the Shelf**

96 **Engineering at Home**
Shaping Diamond and Sapphire
Cheaper Meter Reading
Refrigerator Sales Warm Up

. . . . . .

66 **Management**
Weekly Survey

69 **Plant and Equipment**
Pusher Tug and Barge Train
High Speed Guillotine
Process Plant: The Chemical and Petroleum Engineering Exhibition

78 **Metals and Materials**
Automatic Galvanising Plant: Armco-Sendzimir Installation at Ebbw Vale
Commonwealth Oil
Mechanical Testing of Forgings and Castings
Refining Nickel from Canadian Ores
Argon Purification Installation

80 **The Human Element**

81 **Marketing**

82 **Research and Development**
Avro's Blow-Down Wind Tunnel
High Voltage Trend
Slipping Clutch Fatigue Testing Machine
Atomic Time Standards Compared
Dynamic Rig for VTOL Development
Simpler Microwave Application
Computing Train Timetables
Maser for Pulse Work
Stabilising Klystrons
More Staff for Satellites
Extending Steam Tables

88 **Production**
Research for Production Engineers: PERA's Progress
Transport and Communications in Mining

92 **Design**
Automatic Interception: PIB's Fire Control System
Liquid-Extraction Press with Automatic Conveyor
Overcoming Structural and Operational Complexity
The Westminster Flies
Freight Rates and Tanker Design
Accommodating Tankers
Hydraulic Engineering Courses at Delft

95 **Construction**
Mobile Oil Drilling Platform: First to be built in Britain
Cathodic Protection of Buried Structures
Dispersing Detergent Foam

Since the War

THE engineering industries in Western Europe have had a long and outstanding run of prosperity. In the decade which opened with the end of the war in Europe in 1945 and ended in 1955, there was a steady rate of increase. It began with the rehabilitation of Europe and was carried on in the second half of the decade by the rising level of prosperity throughout the world. In 1956, the pace of progress faltered. Credit restrictions in Western Europe and the onset of the American recession in 1957 were together sufficient to decelerate the industries' rapid rate of increase in capacity and output. But this setback is likely only to be temporary.

The end of the post-war boom (or at least its interruption) and the beginning of a period of more restrained expansion have been marked by a study undertaken by the Machinery Committee of the Organisation for European Economic Co-operation. It covers in particular the years 1955 to 1957, and is reported in a special article in this issue. Between 1953 and 1957 alone, European engineering production increased by over 40 per cent, at a time when the engineering industries in the United States had raised their output by not more than 10 per cent. Crude percentages can be misleading, but the difference between these two figures is large enough to bear out the impression that European engineering was enjoying a period of remarkable prosperity in the middle years of the 1950's.

Over these years engineering has been faced with a shortage of manpower, credit restriction to limit the rate of investment, a high rate of technological change, and pressure from governments to divert output into export markets. It has been able to deal with all these problems while raising its productivity per worker—without social hardship to its employees. All sections of the industry have benefited from the general prosperity, but the outstanding development has been the growth of the transport side of engineering. The motor-car industry in particular has generated a great deal of ancillary activity as it has raised its output to provide cars for a Western European population which has begun to enjoy the benefits of a greatly increased standard of living.

In spite of the general shortage of funds for investment, the engineering industries have raised their capacity by a more intensive application of capital. More and better equipment has been installed. Some of this came at one time through Marshall Aid, and a good deal of it has been paid for by companies having large liquid reserves available for investment after the war. In a few countries such as Germany and Belgium there were draconian measures by the Government, and in Western Germany (at least in the early years) the general public was forced to abstain from buying consumer goods in order that the capital goods industry could be rebuilt. But the willingness on the part of industrialists to accept a philosophy of expansion was not, in the case of the engineering industries, a question of being sheltered by benign governments. It is true that in all countries which are members of OEEC there was a large market for engineering equipment which the industries went for. But in addition, the engineering industries have done well in export markets against severe competition not only from the United States and later from Japan but also at a time of severe competition among companies in OEEC countries.

So much for the past. The industry faces the future with the knowledge that a philosophy of expansion can work. Now, two further tests lie ahead. The first is already taking place. The European engineering industries are now in process of adjusting themselves to a mild recession, which is likely to test for a time both the home and export markets. The test is whether the engineering industries will fight the recession by increasing their efficiency or by trying to adopt measures of restriction. If they are prepared to fight constructively they will press ahead with plans for further modernisation of equipment and the installation of new capacity, competing for markets at home and abroad by means of price competition, good delivery and a high quality of service on spares. The alternative is to take a half-hearted view of the future and cut investment programmes, while hoping for some stability to come to the market by agreement on prices, non-competitive tendering and the dismissal of key workers.

The second test is the impact of the European Common Market. Whether there is a Free Trade Area or not, the European Common Market is a fact and the engineering industries among others will need to adjust themselves accordingly. It will require both boldness and flexibility. Concerns must be prepared to expand quickly to take advantage of new markets, to move their premises or to establish branches in new territories, and to adjust themselves quickly both to favourable and adverse changes in tariffs. To judge from the past decade, the engineering industries are well fitted to meet the next.

Cover Picture. *One stage in the manufacture of a steel oxygen cylinder is shown, namely, the forging of the neck.*

(*Nurnberg photograph for* ENGINEERING.)

★ ★ ★

Plain Words

It is quite surprising how much the principle of the fast line and the slow line is applied to various things in life. The railways long ago realised the value of having two tracks, one for the fast trains and the other for the slow ones. What is true of trains is also true of people in all sorts of activities: some like to move fast, some to take their time, others to vary their speed according to the circumstances. It is important to make provision for these different requirements, and it is important, too, to let others make full use of them. The car driver who seems to be saying " This is a built-up area; I am already travelling at the maximum permitted speed, therefore I will not let anyone else overtake me " —such a man is stubbornly unimaginative. One day, perhaps, he will be in desperate hurry to get to an emergency case.

Talking of cars, I am reminded that the gearbox is itself a device that works on the fast and slow line principle: it allows the car to be driven at a wide range of speeds although the engine is not adapted to such breadth of performance. The piece-worker who works too fast for his mates always has my sympathy: why shouldn't he go faster than them if he is capable of it? If you step on to a London Underground escalator and innocently stand on the left instead of the right, someone is sure to tell you to move over: no offence intended or taken. Why can't it be like that in everything? Trouble arises, I suppose, when the fast mover seems to have something the others haven't got. All men are born equal but some are more equal than others.

The range of newspapers available in this country is an excellent example of provision for different tastes, from the tabloid papers for those who are not prepared to read more than a couple of hundred words without a change in type or a delectable picture, to the logical, solid arrangements preferred by top people. And if a man likes a bit of both, as I do, he can have both—the hors-d'oeuvre and the main course. It's like working in the big city and living in the country.

One notorious application of the principle which has caused widespread argument in Britain in recent years is the eleven-plus examination for schoolchildren. It was probably not intended to be taken in that way, but that is how fond parents see it—and they don't like it when their children appear to be on the slow line. I agree that that is not a particularly acceptable arrangement, but in general I hope we continue to make provision in all our designs for different speeds, and I hope the users will be sufficiently civilised to welcome them.

CAPRICORN

Weekly Survey

Who Owns Canadian Industry?

The fear in Canada that their industry has come too much under control of interests in the United States is well known. There were signs of it in the recent Gordon Commission report on the future of the Canadian economy and it has had an unfavourable effect on political relations with the United States in the last year or so.

The worsening of relations between Canada and the United States resulted in a special commission of the Committee on Foreign Affairs of the United States Congress undertaking a special study on Canada. This has now been published as a *Report of the Special Study Mission to Canada*, House report No. 1766. In this report there is an interesting table of the percentage of ownership and control in selected industries in 1954 taken from the Royal Commission's report on Canada's economic prospects and two other sources. It says that the percentage of capital in Canadian industry owned by the United States in 1954 was 43 compared with 7 per cent held by United Kingdom interests, 49 per cent by Canada and 1 per cent by other countries.

So far as individual industries are concerned United States control is greatest in automobiles, rubber, electrical apparatus and petroleum. It is smallest in iron and steel, transportation equipment and textiles. The largest interest held by the United Kingdom is in chemicals, amounting to 18 per cent. In the 14 industries for which figures are given, the United States has a controlling interest in seven. Canada itself has control in six, and in the last one there is split control among Canada, the United States and the United Kingdom. It is apparent from these figures that the impression which has been held for a long time that United States interests have a big say in the direction of Canadian industry is reasonably well founded. It is probable that since 1954 the control has increased rather than decreased and that the stake held by Western Germany has grown significantly.

Steel Down by Ten Per Cent

U.K. production of crude steel, which throughout 1958 so far has been lower than for the corresponding period of 1957, continued in June the steady decline apparent since the end of March. Production last month was at a week ly average of 373,600 tons compared with 379,000 tons in May and 418,700 tons in June, 1957, a drop of 10 per cent from 1957. So far as most steel products are concerned, consumers' stocks have continued to decline and fewer shifts have been worked at a number of steel plants to avoid an over accumulation of manufacturers' stocks, which began to increase in March this year. As a result, delivery dates have shortened. In contrast, however, new orders, though still declining, are doing so at a slower rate.

In certain sections of the industry, potential demand still outstrips supply. Sheet steel is still required for the motor vehicle industry at a rate in excess of supply, and imports are still necessary. The shipbuilding industry in particular still needs plate in large quantities, and tinplate mills are working near to full capacity following the revival in both home and export demand. The construction industry has suffered from declining orders in the last few months, particularly in housing and industrial building, which has led to contractors reducing stocks and consequently their orders for steel sections.

A general decline in stocks is probably to be expected. They are at present high; at the end of March, 1958, total stocks of finished steel were 4·64 million tons, while home consumption during the first quarter of this year was 3·4 million tons. Stocks have been rising generally for the past three years.

Steel makers are considering the setback as a short-term phenomenon. The industry has so far shown no sign of modifying its long-term expansion plans, though an appreciable drop in total steel production may be expected over this year. Though United Kingdom steel exports for the first five months of the year are 13 per cent lower than for the same period in 1957, the United Kingdom share of the total export market has risen. In Europe, the High Authority of the European Coal and Steel Community believe that the third quarter of the year may see the end of the recession in the steel market. They point to an uninterrupted improvement in real consumption of steel and a revival of orders in some areas.

In the present atmosphere of reducing stocks, a reversal of present production trends in the United Kingdom must depend on the revival of overall industrial expansion. It may well be the end of the year before its full effect is felt.

Where Tankers Come From

Last year both Shell Petroleum and the British Petroleum Company introduced schemes by institutional investors and banks for the financing of tankers then on order. These schemes covered tankers worth £30 million in the case of Shell and £40 million in the case of British Petroleum.

It was revealed last week that Shell are approaching shipping companies, some hitherto not concerned with tanker operation, with certain financial proposals. The shipping companies would take over some of Shell's tankers now on order and charter the vessels to the company at a fixed rate for 20 years. Arrangements have so far been made for six tankers worth at least £10 million to be taken over in this way by, among others, the Pacific Steam Navigation Company and Turnbull Scott & Company.

Though details of the current transactions are not yet known, last year's arrangements with financial institutions provided that the rate at which the vessels would be chartered to Shell would repay the purchase cost plus interest on the capital involved. The interest rates offered have not been revealed but may be expected to be in the region of 7 to 8 per cent. This move was set on foot before the recent relaxation of credit restrictions. The latter may make it easier for other shipping companies to enter into similar agreements with oil companies.

Meanwhile, no recovery can yet be foreseen in the demand for tanker tonnage. World consumption of oil will probably rise by 35 or 40 per cent by the end of 1962. By that time, even if all tonnage over 25 years old is scrapped, world tanker carrying capacity will have increased by an estimated 83 per cent. There is thus on the face of it little hope in the next few years of a recovery in tanker freight rates, a strong probability that a good proportion of tanker tonnage at present laid up will be scrapped and a continuing threat of cancellation orders. The estimates quoted above in fact allow for 10 per cent a year of cancellations.

It is unlikely therefore, that the relaxation of credit restrictions will lead to an upsurge of new orders. They are likely at the most to result in few cancellations. Shipping companies will have less difficulty in borrowing to finance new tonnage owing to the recent relaxation in the procedure by which they can raise new money. They are, however, unlikely to undertake what would virtually amount to speculation in new tanker orders, but they should be secure in financing existing orders with the guarantee of

long-term charters to the oil companies. They nevertheless shoulder the bigger risk if they build the ships for the oil industry to charter.

Social Services on the Firm

The discussions on the European Common Market have produced at least one new result—harmonisation of economic and social policies. Argument has centred on whether different methods of paying for the social services, and different levels of benefit affect the ability of firms in the various countries to compete with each other. So far, however, the spotlight has been on the official social service schemes. Nevertheless, workers receive many benefits which could be classed as a form of social security directly from their employers. The International Labour Office has recently published the results of an inquiry into the prevalence of these non-obligatory services. So far as actual social services—pensions, sickness, unemployment pay and family allowances—are concerned there is a very close connection between the size of the employer's contribution to legally established State schemes and the provision of voluntary schemes. The United Kingdom firms were second only to Denmark in the provision of old age pensions, and easily first in supplementary insurance for injury incurred at work. Italian firms provide practically no benefits outside the State scheme. In Germany the principal benefits are old-age pensions and unemployment pay. French firms pay heavy family allowances. Direct cash payments on birth, marriage, and death were most common in Austria, Turkey, Italy and France.

On the question of subsidised facilities for workers, the report shows some very interesting divergencies. Subsidised educational, cultural and recreational facilities were most common in Denmark, Germany, Greece, and Yugoslavia. But the benefits provided in this category can range from ambitious programmes involving considerable investment and running expenses down to providing a few books or musical instruments. Subsidised medical and health services were most common in Belgium, France and Turkey. Even in the United Kingdom where all residents are covered by the National Health Service, fully 19 per cent of manufacturing establishments reported medical and health subsidies. The facility in the provision of which British firms have an unassailable lead is the Works Canteen. No other country has such a high percentage among the firms examined. Housing funds are one of the least commonly found benefits, except in Germany. The provision of crèches, vacation homes and other family services varies with the percentage of women in the labour force. Yugoslavia, where women form 28 per cent of the wage and salary earners, had the greatest number of these family services.

All told, the great variety of benefits reflects the different ways of life of the communities in which the firms reporting were located. The only generalisation that is possible is that if freer trade has to wait until a single scheme is found to suit them all it is still a very long way off.

ECE to Examine Steel

The Secretariat of the Economic Commission for Europe succeeds in maintaining the extremely high quality of the reports it produces on Europe's economic problems. This organisation is unique among European institutions in having the Iron Curtain countries among its members. This gives added value to the inquiries that the Commission undertakes through making east-west comparisons possible. An inquiry dealing with long-term trends and problems in the European steel industry, which has recently been put in hand, should prove a case in point. Its major aims will be to estimate the long-term trend of steel demand within the framework of the expanding world economy, and the probable evolution of European steel production in relation to both production overseas and world demand. Another object of the inquiry is to assess the adequacy of probable future supplies of raw materials in relation to production plans and the prospects of expanding trade in raw materials. A final aim is to assess European direct steel export prospects, product by product.

Earlier reports made by the Steel Committee in this field are to be revised. These include the report on *European Steel Trends in the Setting of the World Market*, published in 1949, and *European Steel Exports and Steel Demand in Non-European Countries*, published in 1953. Work already carried out on substitution between steel and other materials is to be re-examined in the light of possible changes in the relationship between the prices of materials and steel prices.

As part of its work the Steel Committee encourages the making of all-European contacts and technical co-operation. Many research institutes have arranged exchange visits on particular problems. The Spanish Steel Research Institute is holding a conference for this purpose in October of next year. A similar conference will be held shortly at Liège. It is interesting to notice that apart from the representatives of the member countries the meetings of the ECE Steel Committee are attended by delegates from the International Labour Office, International Confederation of Free Trade Unions and the World Federation of Trade Unions. Its chairman is Mr. P. Van der Rest of Belgium and its vice-chairman Mr. W. Musialek of Poland.

Inflation Under Central Planning

In Britain we are all heartily tired of being told that inflation comes about because we are trying to take out of the economy in consumption, investment and other uses more than it is able to produce. It is some consolation to be reminded in a recent United Nations *Economic Survey* that the Iron Curtain planned economies are all suffering from inflation and that this comes from the same cause. The survey notes that strong inflationary pressures developed in all the centrally planned economies during the initial period of their long-term plans of economic development. These pressures were set up by increases in investment and public expenditure with a consequent cut in personal consumption. An important contributory factor was the inability to fulfil the plans for agricultural production and for increases in productivity which led to lower supplies of consumer goods in relation to money incomes. This problem was more acute between 1949 and 1953. During this period prices generally went up and real wages fell. In the U.S.S.R. itself, where this phase occurred before the War, State prices were reduced after 1949 and have remained largely unchanged since.

After the beginning of 1953 the policy of sharp increases in investment in relation to national product was reversed. Between 1953 and 1956 there was a period characterised by increasing consumption and a relaxation in inflationary pressures. Prices of consumer goods were reduced during this period in spite of the fact that in several iron-curtain countries money incomes increased faster than output. Shortages of consumer goods were apparent in the Soviet Union and several other countries as a result of either excessive reductions of State prices, or of increased money incomes.

In Poland and Hungary the political events of 1956 led to a sharp rise in wages in relation to output, and the balance between demand and supply was only maintained by drawing down stocks of consumer goods. In China, which started industrialisation much later than most other centrally planned economies, the pressure of demand on supply continued throughout the period 1949 to 1953 and indeed increased in 1956 as a result of further shifts of resources towards investment.

Letters to the Editor

COUNTING WITH THE FINGERS

SIR, Ing. Dr. M. P. Varshney's letter and the further contribution by Mr. A. H. Rawle have prompted me to amplify these notes on counting.

There are no reasons other than convention and convenience why anyone should not count and calculate in his own system; no doubt this freedom led to the adoption of the gross (a dozen dozens) which, for some packing and stocking purposes is more convenient than hundreds or thousands.

Bearing in mind that any system must cater for unit increments, a general counting system may be represented by:—

$$b^n = 1 + (b-1)\sum_{r=0}^{n-1} b^r$$

where b identifies the system base.

The common decimal system, when counting from 9999 to 10,000 then operates:—

$$9\,(10^3 + 10^2 + 10^1 + 10^0) + 1 = 10^4 = 10{,}000$$

It is better to view this as:—

$$9\,(1111) + 1 = 10{,}000 = 9999 + 1.$$

In the binary system the array 10,000 is worth only 16 in the decimal system, meaning:—

$$2^4 = 1\,[2^3 + 2^2 + 2^1 + 2^0] + 1 = [8 + 4 + 2 + 1] + 1 = 16$$

and printed $1\,(1111) + 1 = 10{,}000$.

In the quinary system the array 10,000 is worth 625 in the decimal system, meaning:—

$$5^4 = 4[5^3 + 5^2 + 5^1 + 5^0] + 1 = 4\,[125 + 25 + 5 + 1] + 1 = 625$$

printed $4\,(1111) + 1 = 10{,}000 = 4444 + 1$.

The feature common to all systems of counting is that the value of a unit, in any selected denomination, exceeds by unity the maximum possible accumulation in all lower denominations; thus, in quaternary, the same array 10,000 means $3333 + 1$ and in ternary, $2222 + 1$.

The table gives the two decimal numbers 237 (Mr. Rawle's example) and 999 in four other systems, also the decimal system equivalent of the array 1000 in each.

A figure of merit of a system is to be found in the brevity of the written number, consistent with the simplicity of the associated multiplication tables. In the binary, the only digital multiplication ever required is $1 \times 1 = 1$, but the array of digits quickly expands intolerably; whereas, if people could remember multiplication tables of the order 20×20, our present numbering could be much abbreviated by the use of fresh single symbols for the numbers 10 to 19 inclusive. For instance, if a new digit (symbol Δ) represents the decimal number 10, the decimal number 1000 could be denoted by $2\,\Delta\,0$, meaning:—

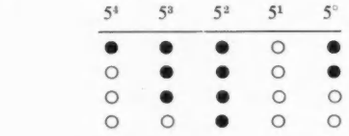
$$2 \times 20^2 + \Delta \times 20^1 + 0 \times 20^0 = 800 + 200 + 0$$

As the human memory does not easily retain such extended tables, it is no wonder that schools rarely go beyond 12×12 and, if the decimal system were not so firmly entrenched, I would certainly be an advocate of an arithmetic based on 5 instead of 10. We should then have the best of both worlds—a bright child would know all the brief tables in less than a week, the highest product being "four times four," while Mr. Rawle's number 237 would gain only one digit (1422). Its binary equivalent on a non-stop vehicle would be quite useless but, on the other hand, the modern electronic circuit turns to great advantage the "do" and "don't" nature of the two digits 1 and 0—a mere switching from on to off. This, accompanied by innumerable $1 \times 1 = 1$ operations, achieves all that is demanded of it.

Counting is as old as the hills, but, whatever modern techniques dictate, it is well to have regard to the rudiments. For instance, labourers still count hods carried by chalking "five-barred-gates" on the wall. It is crude yet effective

Continuing Letters to the Editor

and it does not require much modification to make twenty marks of chalk represent any number between 1 and 3,124, using the labourer's base five and Mr. Rawle's five columns of location, thus :—



Total = 625 + 375 + 100..... + 2 = 1102,
(quinary 13402)

Scope = 4 (625 + 125 + 25 + 5 + 1) = 3124,
(quinary 44444)

SYSTEM	237	999	1,000 denotes
binary	11101101	1111100111	8
ternary	22210	1101000	27
quaternary	3231	33213	64
quinary	1422	12444	125

Yours faithfully,
G. W. MAXFIELD.

1A Adelaide Road,
Southall, Middlesex.
10 July, 1958.

★ ★ ★

SIR, Mr. A. H. Rawle may be interested in a very simple routine method of converting from binary to denary systems of counting, in which the denary number to be converted is divided repeatedly by two until the quotient is zero. The binary representation of the number is then given by the remainders read backwards. Take, for example, his number 237.

	Remainders
2) 237	
2) 118	1
2) 59	0
2) 29	1
2) 14	1
2) 7	0
2) 3	1
2) 1	1
0	1

Then the binary representation of 237 is 11101101.

This conversion to binary is the basis of the well-known trick of "duplation," by which one multiplies any two numbers, using only the arithmetical processes of addition, multiplication by two and division by two. Write the two numbers side by side; divide the smaller successively by two and multiply the larger successively by two. For example:—

27	237 (= 6399)
13	474
6	948
3	1896
1	3792
	6399

Wherever the quotient is an even number, the corresponding product is struck out; the total of the remaining products gives the product of the two original numbers. The validity of this rule can be proved by simple algebra if the two numbers are set up in the general binary form of

$$a \times 2^0 + b \times 2^1 + c \times 2^2 + \ldots\ldots\ldots$$

The problem of binary and denary representation need not arise in ordinary algebra at all: different scales of notation merely describe the same quantities according to different *particular* conventions. Algebra describes the same quantities in a *general* way. For instance, if f is the total number of fingers, h is the number of hands and d is the number of fingers on one hand, then it is true that

$$f = h \times d$$

whether this multiplication is written arithmetically as

	$10 = 2 \times 5$	(scale of ten)
or	$12 = 2 \times 5$	(scale of eight)
or	$20 = 2 \times 10$	(scale of five)
or	$1010 = 10 \times 101$	(scale of two)

or even as

X equals II multiplied by V.

There is, however, a neglected branch of algebra which deals with the properties of different scales of notation. The rule that the digits of all denary numbers divisible by nine will sum to a multiple of nine is a general one. In a number expressed in the scale of eight, for instance, the digits of a number divisible by seven will sum to a multiple of seven. Such rules as these can be discovered and proved by using the general form of an arithmetic number:

$$N = a \times r^0 + b \times r^1 + c \times r^2 + d \times r^3 + \ldots.$$

in which r can be any integer.

Finally, your readers may be amused by the following anecdote. A friend who knew of my interest in scales of notation, set me the following riddle:—

"If twice four is twelve on Mars, how many fingers has a Martian on each hand?"

"Since twelve represents one full group of fingers plus two odd ones, the total number of fingers in a group must be six, and therefore a Martian has three fingers on each hand."

"Wrong. Martians *do* count on their fingers as we do, but they have only two on each hand."

How stupid of me to forget that Martians have three hands!

Yours faithfully,
A. BATTERSBY.

A. Boake, Roberts and Company, Limited,
Carpenters Road,
London, E.15.
10 July, 1958.

★ ★ ★

SIR,—I was much interested in the letter from Mr. A. H. Rawle, published on p. 803 of your issue of 27 June.

The binary system is currently used in modern electronic calculating machines, but it seems rather difficult, at first sight, to see how the simple punched-tape system mentioned by Mr. Rawle could be used for algebraic problems.

The idea in my previous letter (ENGRG., 13 June, p. 739), was to show that one can count up to 1,023 on one's fingers, and not to indicate a way of translating a decimal number to the binary system or vice versa. The figure in Mr. Rawle's letter corresponds to the five fingers of one hand and it is possible to count $16 + 8 + 4 + 2 + 1 = 31$ with five fingers.

Yours faithfully,
M. P. VARSHNEY,
Lecturer in Electrical Engineering.

Indian Institute of Technology,
Kharagpur,
West Bengal, India.
5 July, 1958.

"WHARTON" UNIVERSAL JIG AND FIXTURE SYSTEM

SIR, On page 829 of ENGINEERING for 27 June, you published an article "Jigs and Fixtures from Standard Sets of Parts," referring to this as being devised in Russia.

While this was no doubt published by you in good faith, you appear to have overlooked the fact that this was the British invention, patented, known, and marketed throughout the free world as the "Wharton" Universal Jig and Fixture System.

As we feel that some considerable harm may result from the possible acceptance by present and potential users of the System of the facts as to origin disclosed in the article in question, we trust you will give the widest publicity as to the true position, bearing in mind the article on the System published in your journal (ENGRG., 28 June '46, p. 608).

Yours faithfully,
JOHN WHARTON,
Managing Director.

Wharton & Wilcocks Limited,
20 Bull Plain,
Hertford.
11 July, 1958.

STRAIN HARDENING OF CYLINDERS

SIR,—The article "Influence of Strain Hardening on the Dilation of Cylinders under Internal Pressure," by Dr. E. Voce (ENGRG., 13 June, '58, p. 756) is of considerable interest, and his analysis may prove attractive to many engineers. There are, however, several comments and queries I would like to make about this article.

Firstly, I think it gives the wrong impression to state that Manning's method involves "a laborious arithmetical technique"; in actual fact, it is far from laborious to those who have used it in practice. I and my colleague, Mr. J. A. Bones, have used Manning's arithmetical technique (See our paper "The Behaviour of Thick-Walled Steel Cylinders Subjected to Internal Pressure," to be published in the *Proc.I.Mech.E.*), on many occasions and, when the equivalent strains have been worked out, which need only be done once, the pressure expansion curves for maybe six cylinders can be easily determined in half a day or less. Manning's method has the obvious advantage that it uses the actual stress-strain curve for the material, and unless the approximation to this curve saves a considerable amount of labour it is of doubtful use.

Equation 13 in Dr. Voce's article is attributed to van Iterson but, more correctly, it is due to Saint-Venant (*C.R. Acad. Sci.*, Paris, vol. 74, p. 1009, (1872)) who, however, expressed it in terms of the shear stress. It is not the equation for the initial yield pressure, but it is the pressure at which yield will have completely spread throughout the cylinder wall, if the material yields at a constant tensile stress s_0. Initial yield first occurs at the bore surface at a pressure

$$\frac{\alpha\, s_0}{2}\,\frac{(K^2-1)}{K^2}$$

where s_0 is assumed to be the initial yield stress in tension, or

$$q_1\,\frac{(K^2-1)}{K^2}$$

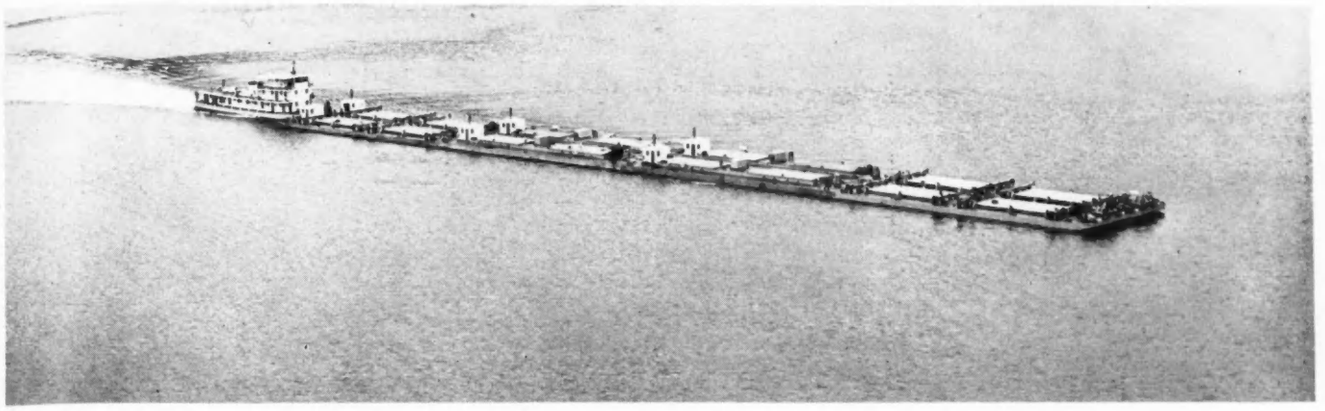
where q_1 is the yield stress in torsion.

Next, I find it difficult to understand equation 18. The engineer's shear strain and the natural shear strain in torsion are the same, that is tan ϕ; there is nothing comparable to the engineer's strain and the natural strain in tension for shear strains. The shear strain, tan ϕ, is directly comparable to the natural strain in tension (See, for example, R. Hill, *The Mathematical Theory of Plasticity*, Oxford, Clarendon Press, p. 29 (1950)). Using von Mises-Hencky function of strains, the shear strain can be converted to natural or true tensile strains by multiplying tan ϕ by $\frac{1}{\sqrt{3}}$, or, if the shear stress criterion is used, by multiplying tan ϕ by $\frac{2}{3}$ (See "Plastic Stress-Strain Relations" by Dr. W. M. Shepherd, *Proc.I.Mech.E.* vol. 159, p. 95 (1948).

Dr. Voce concludes by stating that the results of Mr. J. A. Bones and myself tend to support the maximum shear theory; whereas, in actual

Plant and Equipment

PUSHER TUG AND BARGE TRAIN



The Gongola—a pusher tug—and train of eight barges on trials in the Firth of Clyde before being dispatched to West Africa.

Successful and interesting trials, believed to be the first of their kind to take place in the United Kingdom, have recently been completed on Loch Long, Firth of Clyde, of an integrated barge train. The barge train, which comprises the pusher tug Gongola and eight barge units, measures 630 ft in length overall with a maximum breadth of 66 ft and will operate in service on the rivers Niger and Benue, the terminal ports being Burutu in Nigeria and Garua in the North French Cameroons, representing a round voyage of over 2,000 miles. The vessels have been built by Yarrow and Company Limited, Scotstoun, Glasgow, W.4, to the order of the United Africa Company Limited, London, and under the supervision of Goodwin-Hamilton and Adamson Limited.

A comprehensive series of model tests was carried out at the National Physical Laboratory to determine the optimum performance of the tug and barge units, which were designed by the late Mr. Alexander Kari for "push-towing." The company introduced push-towing to Nigeria in 1950, developing this system from small tows of 60 tons up to one of 2,800 tons, which to date is the largest tow operating on the rivers Niger and Benue.

The pusher tug Gongola is a twin-screw tunnel-type vessel specially designed for "push-tow" duties under shallow water conditions. Her length overall is 105 ft 5 in and on the load waterline 104 ft. The moulded breadth is 23 ft and the extreme loaded draught is 4 ft 5 in.

The main propelling machinery consists of two normally aspirated uni-directional Ruston-Paxman type 16RPHM series II marine diesel engines, each driving a propeller shaft through an oil-operated Hindmarch-Modern Wheel Drive combined reverse reduction gear, with a flexible coupling fitted between the engine and gearbox. Each engine has a rated continuous output at the gearbox coupling of 560 b.h.p. at an engine speed of 1,250 r.p.m., derated to 510 b.h.p. in the service area. Each engine is provided with a closed system of fresh water cooling, with independent heat exchangers. The propellers are of manganese bronze of Unislip design, working in separate tunnels. To ensure maximum manoeuvrability of the barge train, the tug is fitted with two steering and four flanking rudders, all of partially balanced double-plate type, actuated by Vickers-Armstrongs hydraulic steering gear, lever-operated from a control console situated in the wheelhouse.

The electrical supply for lighting and power is generated at 220 volts d.c. and is provided by three Ruston and Hornsby diesel auxiliary sets, capable of developing 15 b.h.p. at 1,200 r.p.m., flexibly coupled to a 10 kW Allen generator. Two of these sets are each arranged to drive a Megator general service pump having a capacity of 15 tons per hour and a Hamworthy air compressor of 15 cu ft capacity.

In operating formation the train comprises nine units, consisting of two leading barges 133 ft 6 in long, four intermediate box barges 130 ft long, two trailing barges 132 ft long, and the pusher tug. The barge units are 33 ft in beam and draw 5 ft loaded. Each barge has three transverse watertight bulkheads forming two cargo holds and the forward and after peak compartments. No longitudinal bulkheads are fitted. The cargo hatches, each 36 ft by 18 ft, are of roller beam type, fitted with 2 in thick wood covers. A two-berth cabin and galley are arranged on each box and trailing barge.

Four Ransomes and Rapier diesel-driven cranes are provided for handling cargo, each with a turning circle of 360° and capable of lifting 1½ tons at 33 ft outreach. One crane is fitted on each of the four barge units forming one side of the train, positioned between the cargo hatches.

When loaded to a draught of 5 ft the complete train has a displacement of approximately 4,650 tons and will be capable of transporting a total of 3,600 tons of dry cargo. For the purpose of the trials held in Loch Long, the eight barge units were sub-divided by temporary wash bulkheads and ballasted with water to the design load draught.

"Push-towing" offers advantages over the more conventional methods of handling dumb barges, the pusher tug having more control over the tow, improving manoeuvrability and reducing the risk of grounding in narrow and tortuous channels, particularly during the low water season in tropical areas. An integrated "push-tow" train also offers less resistance, so that a higher speed is obtained for the same power output or, alternatively, the same speed can be obtained with a greater payload.

Gongola and the eight barge units will be towed out to the port of Burutu in Nigeria by L. Smit and Company of Rotterdam, a feature of the delivery being that the four box barges are being transported "pick-a-back," one on top of each of the other four barges. They will be side launched from the carrying barges after the tows arrive at Burutu.

★ ★ ★

The capacity of the British Coal Utilisation Research Association's slagging gasifier (ENGRG., 4 July '58, p. 3) is 2,000 lb of fuel per hour, not 200 lb.

Continuing Letters to the Editor

fact, they support neither the maximum shear stress theory nor von Mises-Hencky theory. At yield, allowing for size effect, our results agree with the maximum shear theory; in the early plastic region they agree better with the Mises-Hencky criterion; and, at large strains, they disagree with both. However, there is no need to introduce this red herring if it is appreciated that the state of stress in a closed-ended thick-cylinder, even at large strains, is essentially one of simple shear with a uniform volumetric tensile stress, and that the volumetric stress has no influence on the stress-strain curve. (See "The Effect of Fluid Pressure on the Shear Properties of Metals," by Dr. B. Crossland, *Proc. I. Mech. E.*, vol. 168, p. 935 (1954).) If this is accepted, it would be much more sensible to base the results on torsion, as first suggested by Manning (1945), and the question of yield criterion would not enter the matter.

Yours faithfully,
B. CROSSLAND,
Senior Lecturer.

Mechanical Engineering Department,
University of Bristol,
Bristol, 8.
10 July, 1958.

HIGH SPEED GUILLOTINE

A recent addition to the range of tools made by Keeton Sons and Company Limited, Keetona Works, Greenland Road, Sheffield 9, is a high speed guillotine for accurate shearing. It has a capacity in mild steel of 96 in by ⅛ in and a throat depth of 4 in. It is capable of speeds up to 50 strokes per minute.

Maximum rigidity is obtained by the design of the bed and the end frames into which it is fixed. The latter are heavily ribbed on the inside, and are tied at the top with a channel beam, and at the base with two tie-rods. Adjusting screws at each end of the bed provide adjustment of the blades after re-grinding. The cutting beam is a heavy case triangular section, ribbed internally to eliminate all risk of springing during the cutting stroke. The beam is guided in extra wide long slides to minimise wear. The slides extend below the cutting blade, to ensure accurate movement of the beam and to resist the lateral forces exerted by the connecting links. The design of the automatic spring hold-down beam allows the operator a clear view of the cutting line. It is fitted with long rubber pads to ensure a positive grip.

Continuing **Plant and Equipment**

PROCESS PLANT

The Chemical and Petroleum Engineering Exhibition

The Chemical and Petroleum Engineering Exhibition that was held at Olympia in June was the first of its type in this country and would seem to be regarded as a successful venture. The exhibition was organised by F. W. Bridges and Sons Limited, with the support of the British Chemical Plant Manufacturers Association and the Council of British Manufacturers of Petroleum Equipment. The range of plant on show was very great; some other items were described in our issue of 4 July.

CAN FILLER

A problem encountered in some chemical plants today is the handling of liquids that froth very easily. Not least does this occur when detergents are being poured into cans. A machine designed to cope with this, and to give much more rapid filling by weight of any liquid, was on the stand of Liquid Systems Limited. Essentially a custom-built machine, the example at Olympia was dispensing detergent into four-gallon cans. Its general arrangement can be seen in Fig. 7. The can to be filled is placed on the pan of a scale which is immediately below the filling nozzle. The latter is lowered by the handle on the right so that the end reaches the bottom of the can. Thus there is no fall to the liquid, the first flow is slowed down, and frothing is almost entirely eliminated. The pump is then started and the weight monitored until the scale tilts, when the pump is automatically stopped. It is claimed that an accuracy of $\pm\frac{1}{2}$ per cent can be obtained for any weight within the range of the scale. The machine can equally be used for non-foaming liquids when a somewhat quicker rate of filling can be achieved; normally one unskilled operator can handle up to about 60 tons of liquid per week. Spillage is virtually nil and one firm has reported a saving of 1 to $1\frac{1}{2}$ tons of liquid for each 100 tons handled.

The machine measures 3 ft by 3 ft by 6 ft high and can accommodate containers up to 10 gallons capacity. Change-over from size to size takes about ten seconds, and a by-pass is incorporated to permit filling containers up to 45 gallons. The liquid to be filled is normally stored in an overhead tank and feed to the machine is by gravity. Being made in stainless steel as standard, the machine can handle most liquids without risk of corrosion.

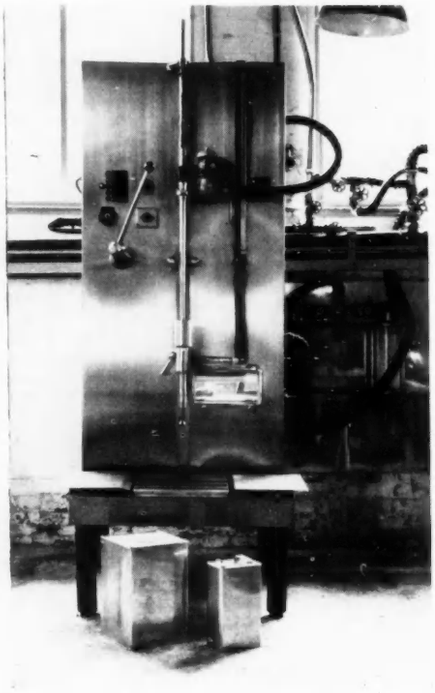


Fig. 7 Dispenser for foaming liquids. Liquid Systems Limited.

FINE FILTERS

Schlegel filters, models F.1 and F.2, shown on the stand of Liquid Systems Limited, Wellesley Road, Croydon, are specially designed for continuous ultra-fine filtration, down to 2 microns. The model F.1 has one filter chamber, while the F.2 model, shown in Fig. 8, has two filter chambers, and these are mounted on a base together with an electrically-driven oil pump.

Each filter chamber is fitted with an inlet and outlet valve, flow indicator, and a pressure gauge which indicates when the filters require cleaning. A remote warning device can be supplied if required.

The filter chambers contain easily removable filters, consisting of a series of two-way filter elements. These elements are composed of a special synthetic filter material which has a service life of several years. Between the filter pads there are pivoted arms which remove the accumulated residues on the filters easily and in a matter of minutes.

The units are fitted with a device on which the filter element is placed for cleaning. A single complete turn of the filter removes all residue. One of the elements is shown in the attached illustration in the cleaning position. An additive can be floated on to the elements to form a sponge-like covering which will absorb impurities and prevent the element itself from becoming clogged. The covering must be renewed by the introduction of more additive after each cleaning. The capacities of the two models are 66 and 132 gallons an hour.

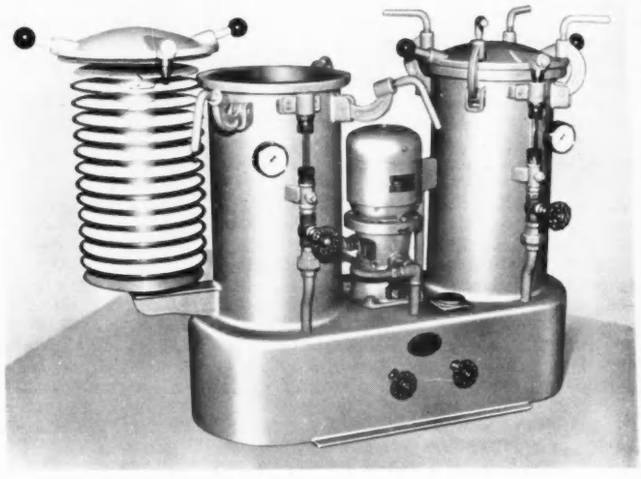


Fig. 8 Two-element filter for particles down to 2 microns. Liquid Systems Limited.

FLEXIBLE DRIVE COUPLING

Metaducts Limited, 3 Catherine Wheel Road, Brentford, Middlesex, were showing the latest addition to their range of Metastream flexible couplings, the CN series. One size is illustrated in Fig. 9. It is a low-price all metal coupling of which the transmission membrane can be removed and replaced without disturbing the drive. At present the maximum size available is $1\frac{3}{4}$ in bore and has a maximum h.p./r.p.m. rating of 0·01. Two other sizes are available with bores of $1\frac{1}{4}$ in and $\frac{5}{8}$ in having ratios of 0·005 and 0·002 respectively.

REINFORCED PLASTICS

B.X. Plastics Limited, Higham Station Avenue, Chingford, London, E.4, showed several recent developments in plastics materials for chemical and engineering plant. One of these was Stelvitite, brought into production by John Summers and Sons Limited, Hawarden Steelworks, Shotton, Chester, which is a method of bonding a plastics coating to steel. The coating can be either Velbex alone (this substance is one of the polyvinyl chloride plastics) or, if a greater degree of protection is desired, a Velbex-Cobex laminate, the Cobex being on the outside. The bonding is sufficiently firm to allow the sheet to be formed by most of the usual metal-working processes, including deep drawing and welding. For the latter operation, the coating is peeled back from the edge by the use of heat and the metal sheets welded together. A strip of plastics can then be bonded over the joint and welded to the existing coating by a standard plastics-welding technique. Normally, the coating is applied to one side of the steel only and the other side is protected by galvanising.

Another very recent development in this connection is the use of expanded metal as a reinforcement. The expanded metal is set in a layer of flexible p.v.c. and then sandwiched between two sheets of rigid p.v.c. The flexible layer allows for any differential expansion between the metal and the plastics, and affords resilience to the whole. Examples were shown of barrels, drums, fume cupboards and the like, constructed from this material, which has considerable structural strength. The metal mesh also holds the fragments together in the event of breakage. As with Stelvitite, this expanded metal can be welded by normal processes, after the outer sheets have been stripped back by the use of heat. The welds can then be covered by plastics strips

Fig. 9 Metastream series CN all-metal flexible coupling. Metaducts Limited.

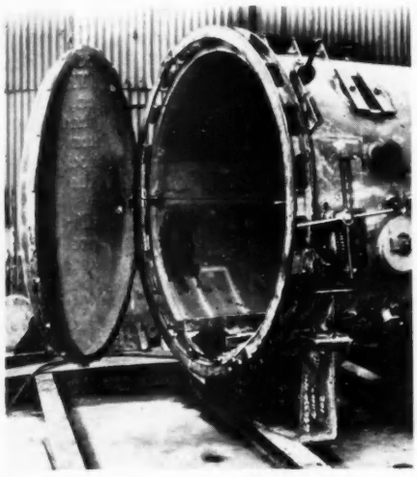


Fig. 10 *Ring clamp for pressure vessel doors. Robert Jenkins and Company Limited.*

or filled by plastics welds. Of the examples shown, the rumbling barrels were made with transparent sheets, as also was the fume cupboard door, but the sides of the latter were opaque.

PRESSURE DOOR CLAMP

A method of door clamping that reduces time and labour was shown on the stand of Robert Jenkins and Company Limited. It is illustrated in Fig. 10.

The ring clamp consists of a number of mild steel clamps, between two mild steel rings, arranged at similar intervals to notches in the flange of the door. Each notch is wide enough to allow a clamp tongue to pass through when the door is to be opened or closed. By rotating the ring clamp a short distance by the worm and wheel mechanism, the clamp tongues engage the tongues of the door flange. The opposing tongues take the pressure load on the door while a rubber gasket ensures a positive pressure seal. The door itself does not rotate so there is no wear on the sealing gasket. The small amount of movement required by the ring clamp for opening and closing the door can be achieved manually or mechanically, by electric, pneumatic or hydraulic equipment. Locking devices and safety bars ensure that the ring clamp will not move while the vessel is under pressure. Ring-clamp boltless doors are available with bolting flanges for converting existing process vessels to this system.

PRESSURISED SYSTEMS

One of the many items on the stand of the General Electric Company Limited, Magnet House, Kingsway, London, W.C.2, was a lighting installation pressurised to prevent the ingress of inflammable gases. It was designed for an internal pressure of about $\frac{1}{4}$ lb per sq. in and incorporated an intrinsically-safe control circuit to shut off the supply in the event of a drop in pressure. Being accident proof, the control circuit can remain energised irrespective of whether pressure is present throughout the system. The main components were a pressure switch, a barrier box for separating the pressurised section from the remainder of the system, and a control unit containing the intrinsically-safe transformer and its associated contactor for isolating the installation. The circuit is such that it is impossible for the main contactor to close unless the whole system is fully pressurised.

AIR-COOLED DIESELS

Exhibited for the first time were examples from the YDA range of air-cooled diesel engines made by Ruston and Hornsby Limited, Lincoln. These engines are of the four-stroke type, made in 2, 3, 4 and 6 cylinder models, with powers up to 110 b.h.p. (automotive rating) at 2,200 r.p.m. Performance curves for the 2YDA are given in Fig. 13 and the 6YDA itself in Fig. 12. The bore and stroke are $4\frac{3}{4}$ in by 5 in, respectively. The cylinder head is a finned aluminium casting with a space between the upper and lower decks to allow the passage of cooling air. The barrel spigots into the head and is fitted with cast-iron valve inserts. Both are attached to the crankcase by high-tensile steel studs, and there is no gasket between the head and the barrel. The cooling air is supplied to the engine from an axial-flow fan and a casing directs the flow over the cylinder block.

The range of power available is extended downwards by the YWA range consisting of two models: a one-cylinder and a two-cylinder unit, developing $11\frac{1}{2}$ and $24\frac{1}{2}$ b.h.p., respectively, at 2,200 r.p.m. These engines are similar to the YDA range, but have a bore and stroke of 4 in and $4\frac{1}{8}$ in respectively, and have a centrifugal-flow cooling fan.

ALUMINIUM PIPING

One of the main exhibits on the stand of the Northern Aluminium Company Limited was a range of aluminium piping in sizes up to 10 in diameter, together with couplings, valves and fittings. One of its main claims is resistance to corrosion and attack by petroleum products; nor does it cause catalytic decomposition of certain liquids. From the point of view of handling, the weight is only one-eighth that of steel pipe of similar capacity, offering savings in transport and laying. The 10 in diameter fittings can withstand pressures up to 2,500 lb per sq. in. It is interesting to note that bends and T-pieces are made from straight tube by a hot drawing process: bends are formed by forcing undersize tube over a curved mandrel and cutting off lengths as required, and T's are made by drawing a plug through a side hole in a tube. Both processes are automatic.

MOLECULAR STILL

One of the items of recent equipment on the stand of Henry Balfour Limited was a Scott-Smith molecular still designed for the separation or purification of high-molecular-weight or heat-sensitive materials under very high vacuum conditions and shown in Fig. 11.

The still is a wiped and accelerated falling film unit continuously and easily operated under a wide range of controlled conditions. A rotating wiper mechanism with detachable slotted PTFE or carbon blades produces a thin, uniform but highly turbulent liquor film. The action of the wiper mechanism also accelerates the liquor film from top to bottom of the heated surface, giving very short contact times.

Within the still are a finned tube condenser and a rotary entrainment separator, both concentric with and parallel to the heating surface. The first is arranged to give a short path flight of the molecules from the heating surface and the second is fitted to the rotating wiper mechanism so that it can be easily removed or installed, as required.

The high operating vacuum is achieved by oil-vapour booster pumps normally backed by gas-ballasted oil-sealed rotary pumps, and the residual air pressure within the apparatus can be reduced to 0·001 mm mercury absolute or less.

Molecular distillation offers particular advantages when heat-sensitive or high-molecular weight (above 250) compounds require processing—for example, vitamins, hormones, sterols, plasticisers, petroleum fractions and vegetable oils—since it takes place at the lowest temperature possible and the minimum contact time with the heating surface. Vapour compositions which result from a mixture on the heating surface depend not only on the vapour pressures of the pure components, but also on their molecular weights. Thus materials with identical vapour pressures but different molecular weights can be separated.

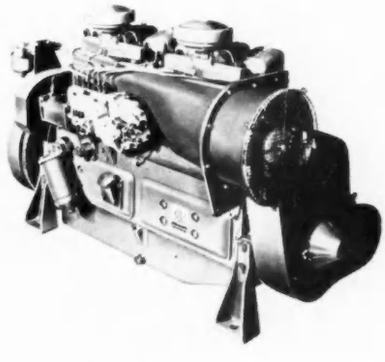


Fig. 12 *The 6YDA air-cooled diesel engine. Ruston and Hornsby, Limited.*

Fig. 11 *Scott-Smith molecular still. Henry Balfour Limited.*

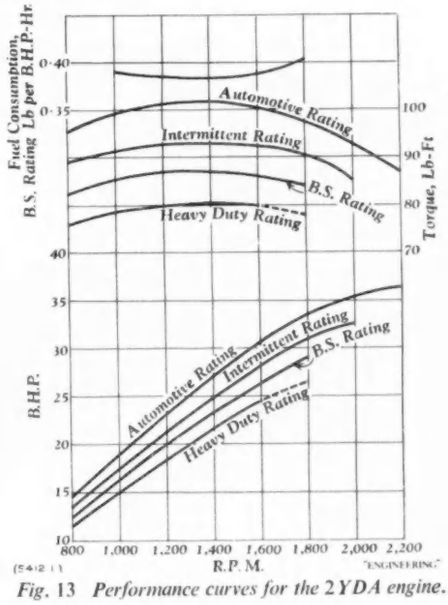


Fig. 13 *Performance curves for the 2YDA engine.*

Companies in the News

Reorganisation of A.E.I.

The British Thomson-Houston Company announced the appointment last week of several further executives to the newly formed A.E.I. Heavy Plant Division, which is to be managed by B.T.H.

This marks a further stage in a long-term plan to reorganise the A.E.I. Group on the basis of type of product. During 1957, the first stage of a complete reorganisation of the business, was completed, and by the end of the year the four Groups within the company—British Thomson-Houston (with the A.E.I. Lamp and Lighting Company, Birlec, and Hillside Foundry Company), Metropolitan-Vickers Electrical (with Ferguson Pailin and Sunvic Controls), Siemens Edison Swan and the Overseas Group—were stated to be working smoothly.

Owing to the increasing size of the business and hopes, expressed by the chairman at the last annual general meeting in April, that it may double in the next ten years, A.E.I. have decided that over the next few years they should change to a divisional organisation based on products. The three principal operating companies—British Thomson-Houston, Metropolitan-Vickers Electrical and Siemens Edison Swan—will manage various A.E.I. divisions under a policy laid down by the board of A.E.I. These companies will remain the instruments through which general A.E.I. policy is carried out, but will devolve some of the executive work upon the divisions.

Initially two A.E.I. divisions have been formed, becoming operative on 1 July. These are the Turbine-Generator Division managed by Metropolitan-Vickers and the Heavy Plant Division managed by British Thomson-Houston. These divisions will now handle the design, manufacture and sales of all products falling within these categories. While many established Metropolitan-Vickers and British Thomson-Houston designs will continue to be available for some years, they will eventually be superseded by a comprehensive range of A.E.I. designs.

Special Steel Uncertain

The annual statement of Arthur Balfour suggests that manufacturers of special steels are now operating under difficult and intensely competitive conditions. Their chairman, Lord Riverdale, discussed a number of factors which are clearly unfavourable—in particular a falling demand and narrowing profit margin—and told his shareholders that on the present and future outlook he has never found it more difficult to forecast. " There are so many factors in the world," he said, " as well as domestic affairs which can affect us, many of them beyond our control, some of them likely to be adverse rather than favourable " that he found it difficult to be optimistic. Times are distinctly tougher and the company are unlikely to maintain the 1957 favourable results " unless there is a favourable turn in trading conditions."

Arthur Balfour take the view that the best way out of the mounting difficulties lies in increased investment in modern machines and processes. They have therefore concentrated their financial and engineering resources on a project to modernise and increase the capacity of their high-frequency melting units and all the ancillary processes. Much of this has been done over the past two years without loss of production and by the end of this year they will be operating a high-frequency melting unit with the highest power per ton in the world, backed by modern handling techniques. " It is our hope and belief," said Lord Riverdale, " that this will enable us to meet competition with increasing confidence."

Firth Cleveland are very similarly placed. Their chairman, Mr. C. W. Hayward, told his shareholders that the American recession " is having its repercussions in this country and will have very serious effects if it lasts much longer. So far it is no more than a hardening of buying in some sectors." In conclusion Mr. Hayward said that it is " most hazardous to forecast events " but that their facilities and energies can even in difficult circumstances meet and overcome the challenge successfully. To the special steels industry the change in the tempo of business is something it has not experienced since its years of tremendous growth. It is better equipped than most to take full advantage of the situation to increase its effectiveness and widen its markets.

Standard Telephones' Seventy-fifth

On the occasion of their 75th anniversary, Standard Telephones and Cables held an exhibition of their products at the Waldorf Hotel, London. There were 99 exhibits extending over their whole range of telecommunication equipment and components, electric cables, electronic test equipment, computers and materials developed especially. Among them there was a crucible free silicon crystal puller representing the latest development in the manufacture of pure silicon crystals and a caesium tube for a caesium clock used to obtain frequency standards of a high order. It was a splendid exhibition, soundly organised and well staffed with engineers and designers to discuss the exhibits with the visitors.

S.T.C., who now employ 25,000 people at eight major factories and locations in the United Kingdom, began as a small importing agency established in 1883 with a staff of three. When they opened their agency office in Moorgate, in the City of London, the telephone was hardly out of the experimental stages. The urge of man to communicate, say S.T.C., drove him to the development of the telephone and " stemming from it like branches from a trunk there has flourished the kindred growth of the art-science of telecommunications."

The growth of S.T.C. has been closely associated with that of the telecommunications industry in the United States. They are members of the world-wide International Telephone and Telegraph Corporation, through whom they are in close touch with the American Telephone and Telegraph Corporation, one of the largest makers of telecommunication equipment in the world. This exhibition suggests that S.T.C.'s new managing director, Mr. F. C. Wright, has splendid material from which to advance even farther in a field where they already lead.

Realignment at Metal Industries

The difficulties which Metal Industries Limited encountered last year appear to have been overcome. They have increased their trading profit (year ended at 31 March) from £1·6 million in 1956–57 to £1·8 million, and the speech of their chairman, Sir Charles Westlake, suggests that they are much better equipped to face the future with confidence. The sale of their holding of ordinary stock in the British Oxygen Company will increase the capital employed or available for expansion by over £1 million to nearly £10 million. They are now actively engaged in seeking new fields of activity " allied or complementary " to those in which they are at present engaged. In his review of current developments, Sir Charles Westlake said that the principal company in the Group's electrical division, Igranic Electric Company of Bedford, achieved record output and profits and that the performance of Brookhirst Switchgear has been greatly improved. These two companies have now been brought under one management and will be known as Brookhirst Igranic. The new company will be the largest makers of electrical control gear in the United Kingdom.

Changes have also taken place in the engineering division, where Fawcett Preston and Company have merged with Finney Presses. Both companies were engaged in the manufacture of plastics and rubber-extrusion machinery and hydraulic presses and they will now operate from one factory at Bromborough. The Birmingham factory is being closed as outstanding orders are completed. The other company in the engineering division, Farmer Brothers (Shifnal), is an old-established family business of constructional steelworkers, whose activities fit in well with the steel stockholding business of Cox and Danks in the Metals Division of the group.

Sir Charles Westlake's statement will go far to reassure stockholders on the future prospects of the company. He is to publish a statement of the results for the first 28 weeks of the current financial year as soon as possible and expressed confidence in the group's ability to sustain their recovery.

Anniversary for Separator

This month AB Separator of Stockholm is celebrating its 75th anniversary. The company started in the 1870's when Gastuf de Laval produced his first designs. The occasion is being marked by a display in Stockholm throughout the summer.

About 11 million farm separators have been sold by this company in its time, some of them through foreign subsidiaries. As the development of new dairy techniques increasingly supplants the farm processing of milk, the Separator Group has turned mainly towards making industrial units. Entire dairy installations are now supplied, which include, in addition to the separating and churning equipment, the stainless steel vats, pasteurisation and homogenisation equipment, plate heat exchangers and vacuum apparatus for removing unwanted flavours.

Apart from milk the de Laval centrifugal technique was applied in 1896 to the first industrial separator—for separating yeast from wort. Today the company makes 150 different types of separators, from small laboratory units to large separators for starch, oils and fats. In 1933 the foam-free hermetic separator was developed and applied to vegetable and animal fats, fruit juices, sugar and other foodstuffs and beverages. One of the most important applications of this centrifugal principle has been the adaptation of the separator for cleaning fuel and lubricating oils in ships.

Uplift for Steels Engineering

New records in turnover and profits, with great financial strength and confidence in the future, were the key notes of the speech to the shareholders of Steel and Company Limited of Sunderland by their chairman, Mr. James Steel. They have just come of age as a public company—this was their twenty-first general meeting—but growth in commercial fields which has taken place has been mainly since the war. Trading profits last year amounted to £1·2 million, £267,000 more than in 1956. Reserves and undistributed profits at the end of the year totalled over £2 million.

The group's principal business, carried out by Steels Engineering Products, is the design, manufacture and marketing of Coles mobile cranes, to which has recently been added agricultural machinery (the Lundell forage harvester). The next largest company, Steels Engineering Installations, have developed extensively in the manufacture of tubular products, especially heating coils for tankers which have formed a large part of the company's business in recent years.

Mr. Steel mentions that " further possibilities of manufacture are being actively explored." Other companies produce castings, alloy steels, catering machinery, and light alloy flooring for marine and industrial applications for which a new factory is planned at Kirkintilloch near Glasgow. The group's live management are taking full advantage of new developments in the engineering field and their strong financial position should enable them to forge further ahead despite a marked fall in the order intake for cranes.

Atomic Review

Part and Parcel

CATEGORIES are a creation of human minds, and certainly have their uses. For convenience, the following notes have been arranged in groups—the resources of British nuclear companies, the current position of the American nuclear programme, and aspects of thermo-nuclear research.

What Britain Offers

Britain's Nuclear Contribution

Britain Leads in this Nuclear Age is a booklet outlining United Kingdom work in the field of atomic energy and describing what British firms and organisations have to offer. Published by the Nuclear Energy Trade Association's Conference, 32 Victoria Street, London, S.W.1, it opens with the statement: "British industry welcomes inquiries for the design and construction of nuclear power stations of large or small generating capacity; research reactors; processing and handling plants; and the whole range of ancillary nucleonic and electronic equipment which is required for atomic energy plants, hospitals, research laboratories, and industrial plants of all kinds."

Selling Nuclear Power Plants to Europe

Mr. Harold Macmillan, the Prime Minister, recently gave details about the export of nuclear power plants to European countries. He thought such plants were unlikely to be purchased by the European Atomic Energy Community, but rather by individual undertakings in member countries. Manufacturers in the United Kingdom have received a number of inquiries from such undertakings and a letter of intention to purchase had been signed between an Italian organisation and a United Kingdom group. The British Government hoped to conclude agreements with the Community and, where appropriate, with member Governments, in order to provide the necessary framework within which such exports would take place. An agreement of that nature with the Italian Government was already in force.

Sweden May Buy British Reactor

Atomkraftkonsortium Krångede AB & Co is a consortium of companies which aims to have a large power-reactor in operation by about 1965 in addition to Sweden's domestic programme, under which AB Atomenergi will complete Eva in 1964. A delegation from the consortium visited England recently and received offers from the five main nuclear groups. Both countries use natural uranium, but Britain has so far used graphite as moderator and carbon dioxide for heat transmission, whereas Sweden uses heavy water for both. The proposed station will be sited in southern or central Sweden, since at present these areas have to import most of their power from Norrland. Reference to this project was made in the *British-Swedish Economic Review*.

Resources of a Nuclear Company

For the purpose of applying to comprehensive nuclear projects the engineering knowledge of two major concerns a company has been formed, to be known as Hawker Siddeley John Brown Nuclear Construction Limited, in which the Hawker Siddeley Group Limited and John Brown and Company Limited each own half the capital. The immense resources of these two companies from heavy power plant and metal fabrication to instrumentation are fully described in an illustrated booklet which may be obtained from the company at 4 The Sanctuary, Westminster, London, S.W.1.

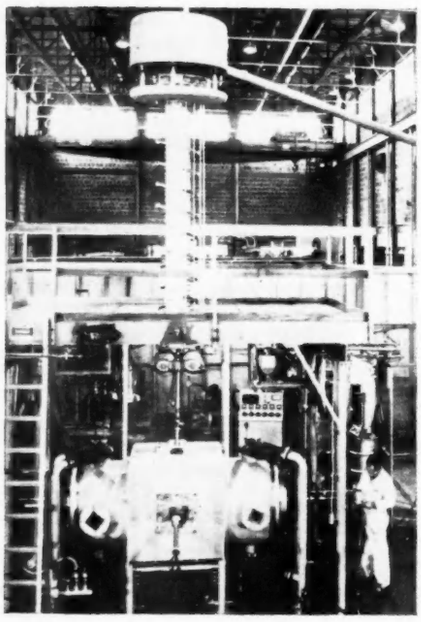
Babcock and Wilcox in Britain and America

It is announced by Babcock and Wilcox Limited that after many years of co-operation with the Babcock and Wilcox Company of America in the design of conventional steam-raising plant, these two companies have now extended their technical collaboration into the nuclear power field. Babcock and Wilcox Limited has an experience of some ten years in nuclear engineering in collaboration with the United Kingdom Atomic Energy Authority. It collaborated with the Authority in the design and construction of all the specialised steam-raising plant for the Calder Hall and Chapelcross atomic power stations of the Atomic Energy Authority, and, as a member of the English Electric—Babcock and Wilcox—Taylor Woodrow Atomic Power Group, is currently engaged in the construction for the Central Electricity Generating Board of the 500 MW nuclear power station at Hinkley Point. The Babcock and Wilcox Company became involved in the American nuclear programme over ten years ago, and has co-operated closely with the United States Atomic Energy Commission on nuclear developments and has designed and constructed many pressure vessels and heat exchangers for the American programme. The company is also the principal contractor for the design and supply of the pressurised-water thorium converter reactor and the steam raising equipment for the Indian Point power station of the Consolidated Edison Company of New York. It has too a contract for the supply of the complete propulsion plant for the world's first nuclear-powered merchant ship, N.S. Savannah, which incorporates a pressurised-water reactor. The company's production facilities include the first privately built factory for the fabrication of nuclear fuel elements and a laboratory for the testing of reactor cores under critical conditions.

NPPC in Rome

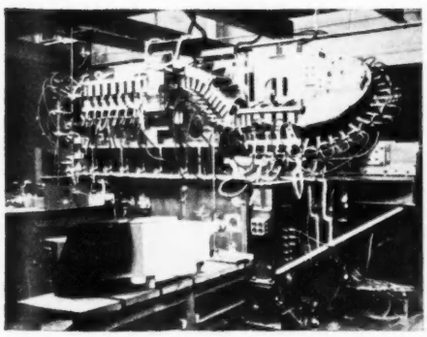
The Nuclear Power Plant Company Limited of Booths Hall, Knutsford, Cheshire, share a stand with their Italian associates, Agip Nucleare of Milan at the Fifth Electronics and Nuclear Exhibition in Rome. NPPC recently signed an agreement with Agip Nucleare for collaboration in the design of nuclear power stations in Italy. This agreement is to be followed by a contract for the construction of a station with an output of 200 MW (a single gas-cooled, graphite-moderated reactor) which will be built at Latina, some 40 miles south of Rome. Work is expected to start this month. The main exhibit on the stand (supplied by NPPC) is a model of a complete nuclear power station.

Other items on show supplied by British manufacturers include a full size bank of boiler tube elements of the Bradwell type, exhibited by Clarke, Chapman and Company; two panels containing a typical selection of fuel cans, and a selection of new metals used in the nuclear industry (zirconium, titanium, etc.) shown by ICI; a model of a flux monitoring cubicle as used in the control room of a nuclear power station, and mounted on the working rack, a ratemeter, a logarithmic ratemeter, a scaler, a prescaler, a shut-down amplifier, a logarithmic d.c. amplifier and period meter, made by General Radiological Limited; and five valves made by Hopkinsons Limited. Agip Nucleare showed a reactor simulator and samples of uranium ore

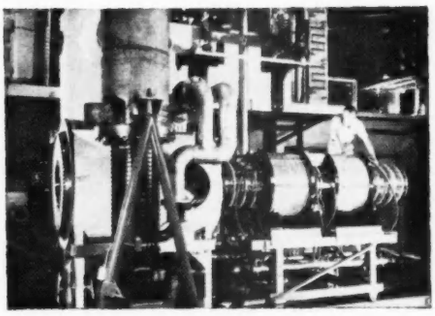


(a) Hot-ion injector—Oak Ridge National Laboratory.

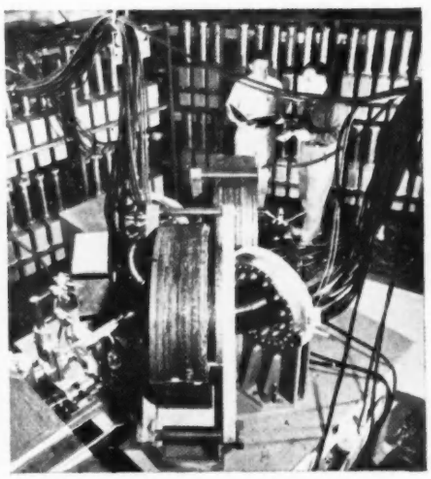
Four United States approaches to the thermo-nuclear research.



(b) Stellerator—Princeton.



(c) Mirror machine—University of California Radiation Laboratory.



(d) Pinch machine—Los Alamos Scientific Laboratory.

Continuing Atomic Review

prospected by their associate company Somiren in Italy and Sardinia.

American Programme

United States Programme to Date

In an account of the United States atomic energy programme, Mr. Lewis L. Strauss stated that the US Atomic Energy Commission's own experimental programme included reactor experiments to explore and test 10 design concepts. In addition, four plants representing private capital investment of 250 million dol and more than half the total kilowatts projected were now under construction. For the eight jointly-sponsored projects not yet building USAEC funds of 150 million dol for hardware and other assistance were more than matched by industry commitments of 200 million dol. The total number of plants to be in operation by 1964 would be 23 with a total electrical output of 1,300 MW. The 23 power reactor projects, located throughout the United States were as follows.

1. Experimental Breeder Reactor No. 1.
2. Boiling Reactor Experiment.
3. Experimental Boiling Water Reactor.
4. Sodium Reactor Experiment.
5. Vallecitos Boiling Water Reactor (General Electric Co.).
6. Organic Moderated Reactor Experiment.
7. Homogeneous Reactor Experiment.
8. Shippingport Atomic Power Station.
9. Commonwealth Edison Co.
10. Consolidated Edison Co.
11. Power Reactor Development Co.
12. Yankee Atomic Electric Co.
13. Experimental Breeder Reactor No. 2.
14. Rural Co-operative Power Association.
15. City of Piqua, Ohio.
16. Consumers Public Power District.
17. Chugach Electric Association.
18. Northern States Power Co.
19. Carolinas-Virginia Nuclear Power Associates, Inc.
20. Pacific Gas and Electric Co.
21. Pennsylvania Power and Light Co.
22. East Central and Florida West Coast Nuclear Groups.
23. Gas Cooled Power Reactor.

Not included were military power reactors and the nuclear propulsion system for the first merchant ship, the N.S. Savannah. Also excluded were projects involving construction of reactors to be installed in other countries. The pending agreement with the six-nation Euratom group contemplated United States assistance in the construction and operation by 1963 of reactors to produce 1,000 MW of electricity.

Research on controlled thermonuclear reactions was being strongly supported. During fiscal year 1958, 20 million dol was being spent on operating the programme and this amount was to be doubled in 1959. More than 250 scientists and engineers were now engaged in this research. The photographs show devices used in four approaches. Programmes based on the pinch effect were being conducted by the Los Alamos Scientific Laboratory and by the University of California Radiation Laboratory. The University of California was also investigating the magnetic mirror approach. The Stellarator programme was being pursued by Princeton University. The approach by hot-ion injection was being developed at the Oak Ridge National Laboratory. Reference to these approaches was made in Atomic Review last 16 May.

Nuclear explosives could be turned to peaceful use. Investigations now proceeding under the title Project Plowshare would seek to determine the feasibility of a number of industrial applications. These included excavation of harbours, oil recovery, mining, power production, and the large-scale production of radioisotopes. The initial project may be the excavation of a harbour on the north-west coast of Alaska, perhaps in 1960. A survey of such a project is being conducted.

Future of Atomic Energy in America

Dr. Paul Genachte, Director of the Chase Manhattan Bank's Atomic Energy Division told a representative of ENGINEERING that atomic energy might be competitive in America in seven or eight years; that breeding would eventually be essential but was not an immediate necessity; and that uranium resources were such as to postpone for perhaps 20 years any significant demand for thorium-converting reactors. He also believed that at present fusion reactors could be dismissed from commercial consideration (a view confirmed by the United States Atomic Energy Commission). Fission reactors, he believed, would be in service for all foreseeable time—fission had not, nor would it, put coal out of business. At present it seemed that the minimum output of a fusion reactor plant would be half a million kilowatts—a large figure even for a base-load station, though fission reactor stations of this capacity are being built in Britain.

Food Irradiation Reactor

Fifteen companies have submitted proposals for the design, construction and test operation of a cobalt 60 gamma food irradiator to be built at the U.S. Army Ionising Radiation Center at Sharpe General Depot, Lathrop, California. The facility, to be known as HI-FI (High Intensity Food Irradiator), will be used by the Army Quartermaster Corps in connection with its food preservation project at Sharpe General Depot. The source of radiation for the facility will be approximately 2,000,000 curies of radioactive cobalt 60, an amount several times greater than all the cobalt 60 now in use in the United States (about 350,000 curies).

SRE at Design Power Level

The design power level of 20 MW of heat was reached by the Sodium Reactor Experiment (SRE) on 22 May, 1958. The SRE is an experimental civilian nuclear power project built and operated for the Atomic Energy Commission near Los Angeles, California, by Atomics International, a division of North American Aviation. Operation at full power followed a scheduled series of low power tests of the reactor core, coolant systems and related components which began last year. The Southern California Edison Company is purchasing the heat and converting it to electricity at its generating plant adjacent to the reactor for distribution through its transmission lines. (The SRE's heat can be converted to 6 MW of electricity). Experience gained from the SRE is being used by Atomics International in its development work for the 75,000 net electric kilowatt central station nuclear power plant being built by the Atomic Energy Commission and the Consumers' Public Power District of Nebraska.

Nuclear Rocket Propulsion

Mr. Lewis L. Strauss has announced the completion of the assembly of an experimental reactor to be used in Project Rover, a study by Los Alamos Scientific Laboratory to determine the feasibility of nuclear power for rocket propulsion. The reactor, known as KIWI-A, will be tested late this year in initial static ground experiments at the Nevada Test Site. KIWI-A, named after a flightless New Zealand bird, was designed and built at Los Alamos where work on Project Rover has been under way for about three years. The reactor shell and support equipment were designed and built at the South Albuquerque Works which is operated for the Commission by A.C.F. Industries.

Gas-Cooled Ship Reactor

The US Atomic Energy Commission and Maritime Administration have executed a cost-plus fixed-fee contract with General Dynamics Corporation for development work in connection with a gas-cooled nuclear power plant for merchant ship propulsion. The work will be done by two divisions of General Dynamics—General Atomic Division, San Diego, California, and Electric Boat Division, Groton, Connecticut. The initial phase of the project which is known as the Maritime Gas-Cooled Reactor (MGCR) includes development of high temperature fuel elements, reactor controls and compatible power generation machinery and selection of coolant and moderator. The design, construction and test operation of a prototype plant are contingent upon successful completion of the development work. It is estimated that it would take five to seven years for the entire programme. Studies previously made for the Commission and the Maritime Administration indicate that a gas-cooled type of propulsion plant would weigh less than other types of nuclear power plants and would operate safely in port and at sea. However, the studies also show that further advance in both reactor and gas turbine technology as covered in the initial phase of the project must be made before the system can be successful.

Geneva Conference and Fusion

Of the 2,370 abstracts so far submitted by 45 countries for the second United Nations Conference on the Peaceful Uses of Atomic Energy, some 100 are concerned with controlled fusion studies. Altogether about 600 papers will be selected for oral presentation. Dr. Sigvard Eklund, conference secretary-general, has stated that 62 governments have indicated their intention of participating. Titles of papers on fusion received to date refer to the following subjects: methods of heating deuterium gas, plasmas, pinch effect, heat-resisting materials, the performance of various thermonuclear devices, and the production of tritium. Papers will describe such devices as Zeta, the Stellarator at Princeton, the DCX direct-current experiment at Oak Ridge, the mirror machine or Pyrotron at Livermore, and a Soviet toroidal-chamber apparatus. Associated with the conference will be a scientific exhibition. (Concurrently with the conference there is also to be a commercial exhibition but it will not be linked directly with the conference). At the scientific exhibition will be exhibited various models and actual apparatus connected with the thermonuclear research. There is to be a model of Zeta, operating devices from the United States, and models, diagrams and other items from the USSR, France and elsewhere. The fusion exhibit will supplement discussions at the conference. The conference will be held in the Palais des Nations, Geneva, from 1 to 13 September.

Power for Zeta

The design and operation of Zeta has been described previously (ENGNG., 31 January '58, pp. 135-136). To charge the condensers subsequently discharged into the primary circuit to raise the temperature of the deuterium gas by induction, high voltage d.c. rectifier plant was supplied by Standard Telephones and Cables Limited. This consisted of four pieces of apparatus: (i) an oil-immersed high voltage transformer, 3 phase, delta-star connected, with a maximum output of 23·5 kV (line) at 3·3A r.m.s. Input is from a 415 V, 50 cycle, 3 phase supply; (ii) a totally enclosed, oil-immersed, high voltage SenTerCet rectifier unit, liberally rated to give an output of 26 kV at 4 amperes. The unit contains banks of SenTerCet selenium rectifiers in 3 phase bridge circuit; (iii) an oil-immersed, 3 phase, auto-wound regulating transformer to give smooth and continuous " on-load" variation of the high voltage d.c. output. The regulator is motor driven and remotely controlled from the control cubicle; (iv) a SenTerCet low voltage control cubicle incorporating a manually operated three-pole-air break isolator, fitted with Castell interlocks and a three-pole air-break contactor.

Self-Sustaining Thermonuclear Reaction

Dr. O. Kofoed-Hansen, of the Danish atomic energy research establishment at Riso, has shown theoretically that a self-sustaining thermonuclear reaction is only possible if some tritium is present in the deuterium fuel.

Swedish Fusion

An experimental apparatus similar to Britain's Zeta unit has been produced at Uppsala University, with the collaboration of ASEA and the State Power Board.

In Parliament

PUMPED STORAGE HYDRO-ELECTRIC SCHEMES

Among a number of questions on Scottish subjects which came before the House of Commons last week were some relating to the progress being made with hydro-electric schemes. Mr. Gerald Nabarro (Conservative) asked the Secretary of State for Scotland what pumped-storage schemes had now been prospected by the North of Scotland Hydro-Electric Board and for information regarding the costs of such schemes.

He suggested that the total power resources from pumped storage was about 15 times as great as the Strathfarrar and Kilmorack hydro-electric schemes, and that pumped-storage arrangements represented only one-quarter of the capital cost of orthodox hydro-electric projects. He felt, therefore, that it was desirable in the national interest that the Strathfarrar and Kilmorack projects should be deferred and the much cheaper and more economical pumped-storage arrangements proceeded with at once, to work in conjunction with the nuclear-power generation facilities from the South of Scotland.

Mr. Niall Macpherson, one of the three Joint Under-Secretaries of State for the Department, said that the Cruachan section of the Loch Awe scheme, which was now under consideration, provided for pumped-storage plant and would have an installed capacity of 400,000 kW at an estimated cost of £37 per kilowatt. The Board had also prospected at Balmaha and Loch Sloy and estimated that it might be possible to develop pumped-storage schemes at these sites, with a further installed capacity of up to 1,600,000 kW at about the same cost.

He said that Mr. Nabarro's assumption that the cost of pumped-storage schemes would be only one-quarter that of conventional hydro-electric schemes was by no means substantiated by the facts. In hydro-electric schemes, it was possible to choose the load factor which was required and to design to it. For a pumped-storage scheme, however, it was first necessary to have supplies available from the base load of a station operating at a high-load factor. Secondly, an adequate peak load demand was needed for the power from the pumped-storage station. What the North of Scotland needed at present was not supplies of electricity for peak loads but for intermediate loads, and the Scottish Office was quite satisfied that the cost of providing such a supply would be far less at Strathfarrar than at any other available centre.

HUNTERSTON NUCLEAR POWER GENERATING STATION

Replying to Mr. Nabarro about the load factor and power costs of the Hunterston nuclear-power generating station, Mr. Niall Macpherson said that the planned average load factor for the station was 80 per cent and that its cost, excluding the initial fuel charge, was estimated to be £111 per kW installed or £133 per kW distributed. The output would be fed into the Grid of the South of Scotland Electricity Board, with which the proposed pumped-storage scheme at Loch Awe, if approved, would also be linked.

A pumped-storage scheme was operated most economically at a low load factor and could not take the place, therefore, of the conventional Strathfarrar and Kilmorack scheme, which was designed to supply electricity for intermediate loads at a load factor of 29 per cent on the Board's system. It was quite wrong to assume that supplies from pumped-storage sources would be produced at lower costs and he thought that Mr. Nabarro had not taken into account the cost of supplying the power from the base-load nuclear-power stations, which would be required to make the pumped storage possible. Mr. Arthur Woodburn (Labour) affirmed that pumped storage was used only at high peak-load periods of the day and that it was no economy to produce nuclear power stations at an enormous cost merely to pump up water that could not be used economically. Mr. Macpherson agreed with this statement and said that the purpose of the Strathfarrar scheme was to meet intermediate electricity needs, whereas the purpose of pumped-storage arrangements was to supply electricity during peak periods.

ENGINEERS FOR FACTORY INSPECTORATE

Problems relating to the Factory Inspectorate were raised by Dr. Barnett Stross (Labour), who wanted to know whether the Minister of Labour and National Service had yet succeeded in trebling the size of the Chemical and Engineering Branch of the service, and whether the Minister could guarantee that the Inspectorate was getting a sufficient priority in respect of highly-skilled professional people, such as engineers and chemists.

Mr. Iain Macleod said that, since the publication of the White Paper on the *Staffing and Organisation of the Factory Inspectorate* (HMSO, Cmd. 9879, 1956, 2*s.*), the number of engineering and chemical inspectors on the role had been increased from 18 to 24, and six more such posts were in process of being filled. An open competition to fill the remaining vacancies would shortly be advertised. He could give an absolute assurance that the comparative slowness in recruiting, which was much regretted, had nothing to do with any measures for economising, or anything of that kind. He had always had the full support of the Treasury. He was not quite sure, he told Mr. Joseph Slater (Labour), that it would be possible to publish the areas which were covered by the chemical inspectors, but he would look into the matter.

SITING A LARGE NEW STEELWORKS

Various members urged upon the Paymaster-General the need for making an early decision regarding the siting of the new steelworks for Richard Thomas and Baldwins Limited. Mr. H. R. Gower (Conservative) asked for an assurance that no step would be taken to prevent the company siting their new undertaking in South Wales, as they wished to do. He pointed out that the firm had had a long association with the district, and that both the company and the Iron and Steel Board had expressed an opinion that the best site was in South Wales.

Mr. James Griffiths (Labour) also pressed for an early announcement " because of rivalries, rumours, and so on." The future of communities depended upon the decision and it was better for all that they should know where they stood. Mr. Malcolm MacPherson (Labour) considered that the over-riding consideration should be the public interest. In Scotland, where the decision was of vital importance, great assistance would be given to the public if it were only known how long it would take before a decision was reached.

In reply, Mr. Reginald Maudling said no decision had yet been reached but all the considerations mentioned were being taken into account. Very great implications, social as well as economic, were involved. There was also a conflict of genuine interests and the Government must be certain of getting the right answers, even if it meant delay. Such matters could not be decided by either economists or politicians alone. There was a need for the blending of the two.

New Apprenticeship Council

Following upon recommendations made by the Carr Committee in their report *Training for Skill* (HMSO, 1958, 2*s.* 6*d.*), that a central body should be established to keep apprenticeship and training arrangements under constant review, a new council is expected to be set up by the Government before the end of this month. Mr. Richard Wood, Parliamentary Secretary to the Ministry of Labour and National Service, assured Mr. Will Owen (Labour/Co-operative) that the Trades Union Congress would be represented on the new organisation. He said that the Central Youth Employment Executive would shortly be inviting youth employment committees to promote local consideration and discussion of the report, in consultation with employers' associations, trade unions, and those concerned with technical education.

Supports for Coalmine Roofs

An inquiry was made by Mr. Harold Neal (Labour) about the progress being made with the introduction of Roofmaster roof supports into coalmines. Mr. Reginald Maudling said that this system, like others recently introduced, was an attempt to mechanise the process of setting and advancing supports at the coalface and it would be some time before its effect on safety could be judged. It was, a very complicated technical problem and he did not wish to forecast the result, but the idea behind these systems was rather promising and was being pursued with great interest.

A Nine-Year Gasification Experiment

Another matter raised by Mr. Neal was the experiment in underground gasification at Newman Spinney, which, he stressed, had been continuing for nine years. He suggested that, after such a lapse of time, either some commercial results should be obtained or the idea should be written off as a complete loss. Mr. Reginald Maudling said that it was still too early to say whether the experiment would be successful or whether a commercial power station would be erected. It was a difficult project, but the National Coal Board were doing all they could and they believed that it was worth going ahead with their experimentation. Experience in other countries had been studied.

A High-Pressure Gas Grid

The advantages of transporting coal gas under high pressure were referred to in a question by Mr. Albert Roberts (Labour). He was told by Mr. Reginald Maudling that the Gas Council was examining the possibilities of a high-pressure gas grid linking the coalfields of the Midlands with London and Lancashire. There were certainly great economic possibilities, Mr. Maudling said, in transporting gas under high pressure, but the problem of manufacturing gas under high pressure had not yet been solved. There were at least two, and possibly three, experimental plants in being for this purpose, and the gas industry was very well aware of the great importance of this development.

Oil from Coal

Before coal could be economically converted into oil in this country, an efficient means had to be developed of gasifying it at high pressure. Co-ordinated work on other aspects of the problem of oil synthesis, Mr. Reginald Maudling informed Mr. Julian Ridsdale (Conservative and Liberal Unionist) was being pressed forward by the Fuel Research Station and by his own department.

Steel Production in Britain

Sir Ian Horobin, the Parliamentary Secretary to the Ministry of Power, told Mr. Frederick Lee (Labour) that, according to information supplied by the Iron and Steel Board, the production of crude steel by works in Britain, for June last, was provisionally estimated at about 80 per cent of capacity.

European Nuclear Research Costs

Replying to a point raised by Mr. Roy Mason (Labour) about the income of the centre for European nuclear research, Mr. Harmar Nicholls, the Parliamentary Secretary to the Ministry of Works, said that the income required by the European Organisation for Nuclear Research for the calendar year 1958 was 56 million Swiss francs, or about £4,660,000, towards which the British Government would contribute one-quarter.

Special Article

For A Five Year Boom

WESTERN EUROPE OWES IT TO ENGINEERING

WHEN the history of the engineering industry in western Europe comes to be written for the later stages of the industrial revolution it may well be said that the industry never had it better than in the middle years of the Twentieth Century. Between 1945 and 1953 a boom developed in the engineering industry which owed its origin to two main factors.

The first of these, and the most important, was the rehabilitation of western Europe after the Second World War, and the second was the upsurge in industrial activity after the dislocation created by the outbreak of the Korean War. The recovery of western Europe and the tremendous burst of industrial activity over these years is well known. This article is concerned with the second stage of the boom which took place between the years 1953 and 1957 and which has now been documented in a study of the machine committee of OEEC called *The Engineering Industries in Europe* (published by OEEC: Paris). By the end of 1957 the boom had just about spent itself but its consequences are still very much with us.

Between 1953 and the end of 1956 the engineering industry in western Europe increased its delivery of goods by 36 per cent. (Throughout this article western Europe is defined as members of the Organisation for European Economic Co-operation except when otherwise indicated.) The most rapid rate of expansion, measured on the basis of deliveries, was 14 per cent in 1955. It had eased off to 8 per cent in 1956. Over the same period of time the engineering industry in the United States increased its output by rather less than 10 per cent. Indeed in 1956 the European engineering industry delivered engineering equipment (including consumer durable goods) valued at over 35 billion dol, of which 70 per cent was sold in domestic markets, 12 per cent in intra-western European trading and 18 per cent was exported to non-member countries.

MORE ON RESEARCH

Employment in the industry increased steadily between 1953 and 1956. Here again, the rate of increase in recruitment built up to a peak in 1955 and eased off in 1956. A feature of the industry in recent years has been the comparatively larger increase in the number of indirect workers in the industry, especially in the electrical and transport engineering sections. This has been partly due to increased mechanisation and partly to a proportionately larger number of workers being engaged on research and development. The way this has taken place and the comparison with development in the United States is given in Table I below.

TABLE I.—*Salaried Employees as a Percentage of Total Manpower*

Branch	Member countries combined		United States	
	1954	1956	1954	1956
Mechanical engineering	22·7	23·8	26·0	23·6
Electrical engineering ..	26·0	27·1	27·0	27·5
Transport engineering ..	18·4	19·4	23·5	25·7
Metal manufactures ..	15·3	15·8	19·7	20·3
Instruments, watches and clocks	20·3	20·8	29·5	31·3
Total engineering ..	21·4	22·4	24·5	23·9

With the exception of mechanical engineering in the United States, there was a noticeable tendency for the percentage of salaried employees to increase in both areas during the two years under review. It will be noticed that except in mechanical engineering, the United States still showed in 1956 a significantly higher percentage of salaried workers than western Europe, but the rate of increase was little different compared with Europe. These figures indicate that the engineering industry in western Europe has held its own in the more intensive use of salaried brain-power of recent years compared with the United States even if it has not significantly closed the gap.

MORE INVESTMENT

An indication that western Europe has been intensifying its investment per unit of output is set out in Table II. This suggests a higher use of capital per workers at a time of labour shortage and thus, by implication, an increase in productivity.

TABLE II.—*Trend of Deliveries of Engineering Goods at Current Prices Compared with Trend in Investment* (1953 = 100)

—	1952	1953	1954	1955	1956
Trends of total value of deliveries†	95	100	111	126	135
Investment	97	100	111	146	166
Ratio between total expenditure on investment and total value of deliveries	5·51	5·35	5·35	6·20	6·55

† Internal transfers within the engineering industry included.

The table indicates a gradual increase in the value of investment as well as a rising trend in the value of goods delivered. The period under review has indeed been notable for the increased "weight" of investment. It is here that one finds the cause behind increased output per worker.

In spite of the rising standard of living in western Europe and the expansion in the engineering industry, the area has shown little tendency to import significantly larger quantities of engineering equipment. Of recent years these have stayed fairly steady at about 3 per cent of the total deliveries of engineering goods. In other words, member-countries of OEEC have remained on the whole self-supporting although they have obviously bought in significant quantities of special equipment, notably from the United States, to increase their own productive capacity. It is of interest that this ability to be self-contained is rather more apparent for the members of the European Common Market than for the other members of OEEC who might come in to form the Free Trade Area.

MORE EXPORTS

On the export side, there has been a tendency for demand for engineering goods to increase recently more rapidly than home deliveries. This is shown in Table III.

The countries which may form the Free Trade Area (excluding the European Common Market group) exported as a whole 25 per cent of their exports to third countries or to members of the ECM in 1956. In contrast, they exported only 12 per cent to non-member countries and 5 per cent to fringe members of the FTA.

TABLE III.—*Trend of Internal and Export Demand for Engineering Products.*
Billion dol at Current Prices (*Index:* 1953 = 100)

—	1952	1953	1954	1955	1956
Internal market:					
Value	20·9	22·6	25·0	28·3	30·2
Index	89	100	110	125	134
Export market:					
Value	4·3	4·2	4·6	5·3	6·0
Index	102	100	110	126	143
Total demand:					
Value	25·2	26·2	29·6	33·6	36·2
of which exports (per cent)	17·2	15·9	15·5	15·8	16·6
Index	94	100	110	125	135

CONSUMER GOODS

So far as the internal market is concerned, a very definite trend for the level of durable consumer goods to keep ahead of total private consumption became apparent over this period. This can be seen from Fig. 1, which compares total private consumption with consumption of durable consumer goods at current prices between 1951 and 1956.

It will be noticed that in 1956 expenditure on consumer durable goods levelled off, whereas total private consumption rose by 8 per cent, but this was largely due to the decline in the United Kingdom of sales of private cars and other durable goods. It is probable that the upward trend of durable consumer goods sales will have continued for 1957 and into 1958 since there has been a significant recovery in car sales in this country over the last 12 months. The report draws attention to the effect of increasing personal income on the demand for durable consumer goods. It points out that to judge from recent experience in western Europe not only does the demand for consumer durable goods increase but there is a shift upwards in demand from lower to higher grade goods. The outstanding example of this is the way in which demand has been transferred from cycles to motor-cycles and then to motor-cars. It seems reasonable to assume that if total private consumption continues to increase, a further

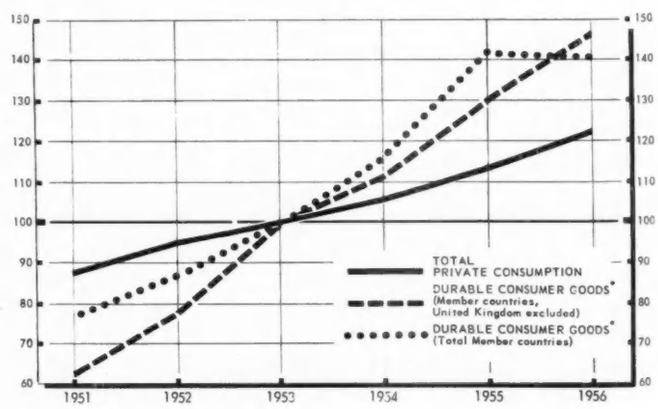


Fig. 1
Comparison of private consumption and consumption of durable consumer goods at current prices. Member countries combined. Index* 1953 =100.

* Sewing machines, radio receivers, television sets, washing machines, vacuum cleaners, motor-cycles, bicycles and motor-cars.

substantial rise in the purchase of consumer durable goods will follow.

The increase in the gross national product of western Europe of recent years has been accompanied by a considerably larger increase in investment in machinery and transport equipment. This is brought out in Fig. 2.

In the expansion of investment it does not appear that since 1955 defence requirements have played a critical part. It might have been expected that the slowing down in defence outlay would have acted as a brake on investment. Although production for defence amounted only to 10·2 million dol in the financial year 1955-56, compared with 46·3 million dol in the year before, none of the individual economies affected found much difficulty in taking the drop in defence orders in their stride.

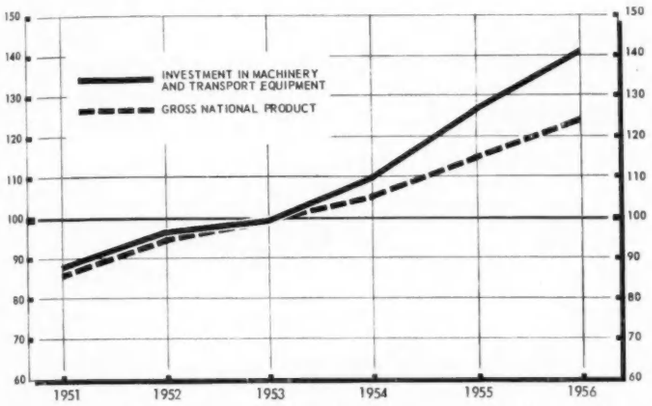


Fig. 2 Trends of consumption of engineering capital goods and of gross national product at current prices. Member countries combined. Index 1953 = 100.

As has been said above, in 1955 and 1956 the export of engineering equipment from western Europe expanded more quickly than home demand. Some idea of the pattern of exports in the latest year for which figures are available can be got from Table IV.

TABLE IV.—*Percentage Split-up of Production and Exports of Different Types of Engineering Equipment*

Products	1956 pattern of:	
	Exports to non-member countries	European production
Machinery other than electric	37	35
Electric machinery	18	22
Transport equipment	36	33
Manufactures of metals	5	7
Instruments, watches and clocks	4	3
Total	100	100

UNDER-DEVELOPED COUNTRIES

It will be noticed that the two largest groups in the engineering industry, measured either by output or by exports outside Western Europe, have been mechanical and transport equipment. In 1956 they accounted between them for 68 per cent of output and 73 per cent of exports.

About 80 per cent of extra-European exports from member-countries were directed to the less industrialised countries in the free world and therefore the basic trends affecting export demand are to be found in the pressure which exists at any time towards increased industrialisation in the so-called under-developed parts of the world. It is not surprising therefore that European exports were buoyant in 1956 when world commodity prices were high. More recently, in the period since the report was finalised, many of its markets have suffered severely from the fall in world commodity prices. The drop in their purchasing power makes Western European engineering exports vulnerable to a drop in demand from this source. Table V is a split-up of the export market for European engineering goods in 1956.

TABLE V.—*Percentage of Western European Engineering Exports by Areas*

Overseas territories of member countries	18·8
North America	13·4
Central and South America	14·8
Non-member countries of the Sterling Area	28·1
Other non-member countries	24·9

Broadly speaking, the tendency for OEEC countries to experience particularly buoyant exports of transport equipment and machinery other than electrical followed a world trend. This can be seen in Fig. 3.

Between 1954 and 1956, engineering exports to North America expanded by 60 per cent, and those to other countries in the Dollar Area by 14 per cent. By far the largest exporting countries were the United Kingdom and Germany, but all members of OEEC increased their dollar exports substantially except France and Denmark. Furthermore, the engineering exports to the Dollar Area between 1954 and 1956 were increasing at nearly twice the speed of exports of all goods.

It is also noticeable that there is no apparent connection between the level of exports to the United States and the market which a member-country in turn provides for engineering imports from America. Thus Germany has been the second largest exporter but is one of the smallest importers. France is a small exporter but a major importer, and so is Belgium. The United Kingdom is both a major exporter and a major importer.

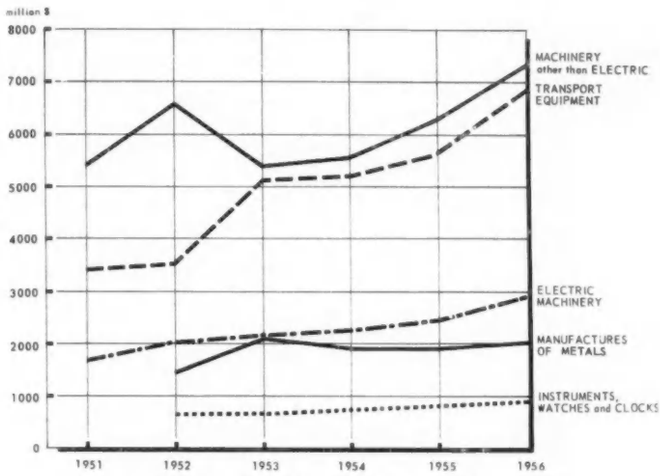


Fig. 3 Trends of world trade in engineering products.

COUNTRIES COMPARED

The outstanding performance of the western European engineering industry in the last decade has been accomplished by a group of national industries exceedingly diverse in their structure. The average number of persons employed per establishment in 1955 in Austria was 165, in Belgium 75, in Germany 173, in Norway 69, in Sweden 87 and in the United Kingdom 236. These figures suggest a great deal of diversity as between the industries of one country and another. They also emphasise that although there are some very large engineering companies in most of these countries, the industry is on the whole characterised by small organisations.

In *Austria* in 1955 there were about 140,000 people engaged in the engineering industries; 42 per cent of the establishments in it produced machinery other than electrical, 23 per cent electrical machinery, 21 per cent were manufacturers of metals, and the transport equipment industry accounted for 10 per cent of the total. Between 1950 and 1955 the structure of the industry had changed but little. The number of plants increased by 10 per cent but the proportion of large and small plants hardly changed at all.

In *Belgium* in 1954 there were 172,000 wage earners and employees in the engineering industries, which is characterised by a large number of small concerns. There were 19 large plants to account for 30 per cent of the total number employed in the industry.

In *Germany* in 1955 there were nearly 12,000 engineering plants and about three-quarters of them were small, with 10 to 100 employees. At the other extreme there were 362 establishments with a manpower of over 1,000. Between 1950 and 1955 the number of plants increased by nearly 5 per cent and total manpower went up by about two-thirds.

In 1950 there were 5,500 engineering establishments in *Italy*, nearly half of them being on the mechanical side. There is in Italy a heavy concentration of workers in the transport equipment industry. In 1955 over one-third of the total number of workers and employees in the engineering industry were in transport of some kind, and it is in this category where the largest number of big establishments are classified.

As would be expected, in the *Netherlands* the electrical engineering industry is of great importance. It accounts for only 11 per cent of the total number of plants of 10 persons and more but it employs nearly 30 per cent of the industry's total manpower. The average number of persons per establishment in electrical engineering was 237, compared with 63 in mechanical engineering and 76 in transport.

In *Sweden*, out of 276,000 workers, more than 28 per cent were engaged in 1955 in 1 per cent of the total number of plants having more than 10 wage earners. Despite Sweden's high reputation in electrical engineering, the largest branch is mechanical engineering, which accounts for 42 per cent of the labour force, followed by transport engineering with 26 per cent.

These figures from other countries in western Europe can be compared to a limited extent with those for the *United Kingdom*. In 1955 there were 2,787,000 employees in the engineering industries. The mechanical engineering industry at that time accounted for 50 per cent of the establishments but only one-third of the employees. The electrical engineering industry accounted for 23 per cent of employees, and transport engineering industry 37 per cent during the same period.

Western Europe's engineering boom was therefore the achievement of many small and enterprising concerns as well as of the giants. So will its achievements be in the future.

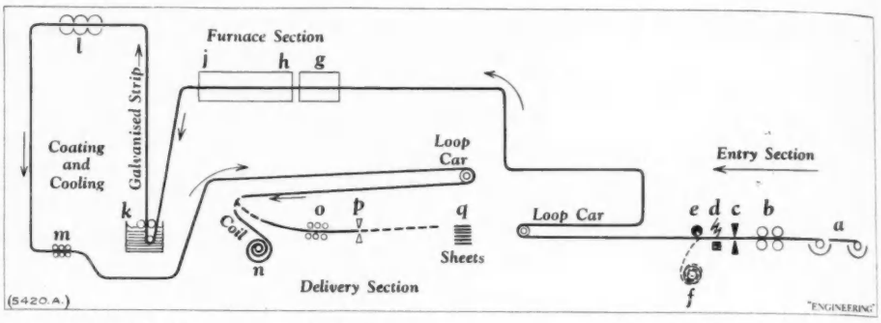
Metals and Materials

AUTOMATIC GALVANISING PLANT

Armco-Sendzimir Installation at Ebbw Vale

A continuous galvanising plant now being put into operation at the Ebbw Vale Works of Richard Thomas and Baldwins Limited, Ebbw Vale, Monmouthshire, is the first of its kind in Great Britain. Employing the Armco-Sendzimir process, which dispenses with pickling treatments and fluxing additions to the zinc bath, the galvanising line has an overall length of 700 ft and consists of five main portions, namely, the entry, furnace, coating, cooling and delivery sections. These are seen in diagrammatic form in Fig. 1. The installation has a potential output of about 10 tons an hour of either galvanised mild-steel sheet or coil, to which the name Speltafast has been given, and it can handle steel strip up to 48 in wide.

The entry end, shown in the foreground in Fig. 2, comprises coil troughs providing storage for two coils, in line with the axis of the pay-off reels, where back tension is applied by means of air-operated water-cooled brakes. The pay-off reels are of the overhung expanding-drum type and are adaptable for 20 in, 24 in and 30 in bore coils. A double-cut shear, equipped with two sets of pinch rolls and guides crops the entry and trailing ends of coils before spot welding them to form one continuous strip. After welding, the strip passes through pinch rolls into a looping pit and then through an edge trimmer, of the overhung driven knife-type, after which a burr masher smooths away any small irregularities left by the trimmer and a scrap baller, underneath and on one side of the line, coils the trimmed strips of edge scrap on to a driven mandrel. The strip then enters a second looping pit and passes on by way of a tension bridle through the entry loop car seen in Fig. 1. Further pinch rolls and a weighted "dancer" roll control the tension of the strip as it passes into the first portion of the furnace installation. In this, a gas-fired flame-heating section, the strip is pre-heated, cleaned and lightly oxidised. From the flame-heating furnace the strip passes into the reducing furnace where it is taken through an annealing cycle in an atmosphere of "cracked" or dissociated ammonia, produced in two electrically-heated ammonia dissociators, each capable of producing 2,000 cu. ft an hour of cracked ammonia. In this furnace, the oxide is reduced and at the same time a matt surface imparted to the strip.



a. Alternative pay-off reels
b. Snubber and pinch rolls
c. Double-cut shear
d. Spot-welding unit
e. Edge-trimmer
f. Scrap baller
g. Oxidising furnace
h. Heating zones
j. Cooling zones
k. Spelter bath
l. Cooling blowers
m. First roller-leveller
n. Coiler
o. Second roller-leveller
p. Shear
q. Sheet piler

Fig. 1 Diagram of Armco-Sendzimir continuous galvanising line at the Ebbw Vale Works of Richard Thomas and Baldwins Limited.

The reducing furnace is of the gas-fired radiant-tube type and the temperature is maintained at between 1,750 and 1,800° F. (955–980° C.) The temperature of the strip is controlled by its speed through the heating gases and this may be varied from 35 to 250 ft per minute. Four cooling zones of the furnace section reduce the temperature of the strip by stages and the exit end of the furnace section has been given the form of a snout which projects below the level of the molten zinc in the galvanising pot. The strip entering the molten zinc is in an annealed state and its temperature is some 50 to 75° F. above the galvanising temperature. This and its matt surface, free from oxide and other contamination, give ideal conditions for zinc adhesion.

The galvanising bath is electrically heated and the zinc kettle, which is of Armco design, is 8 ft 3 in wide, 7 ft 3 in long and 6 ft 1 in deep, and the zinc temperature is maintained between 835 and 870° F (445 and 465° C). The coating unit in the zinc kettle consists of a pot roll, a pair of alloy-steel coating rolls, 10 in in diameter and having a face length of 58 in, and a set of coating-roll wipers.

As may be seen in Fig. 3, the strip rises vertically on leaving the zinc kettle before entering the final cooling section, where cold air is directed over it to harden the coating. After cooling, the strip passes through a first roller leveller comprising 21 working rolls of 2½ in diameter and 69 backing-up rolls. This machine not only levels and flattens the material but gives it the necessary degree of temper and works the strip so as to prevent fluting when it is passed round rolls of relatively small diameter.

The strip travels under the zinc kettle on its way to the delivery section of the plant which, as is shown in Fig. 4, is on the ground level, below the furnace section. An exit loop car, similar to the entry loop car, directs the strip, by way of a second tension bridle providing the necessary back tension, on to a mandrel-type coiler. Alternatively the strip may be sheared into sheets.

For this purpose pinch rolls pull the strip into a vertical looping pit which serves for speed balancing. On emerging from the pit the strip passes through a rocker shear and levelling stand, capable of operating at speeds of up to 350 ft per minute. Prime and reject sheet conveyors and pilers are provided, as well as a retractable oiling machine and an installation for chromate treatment. Other plant provided in this

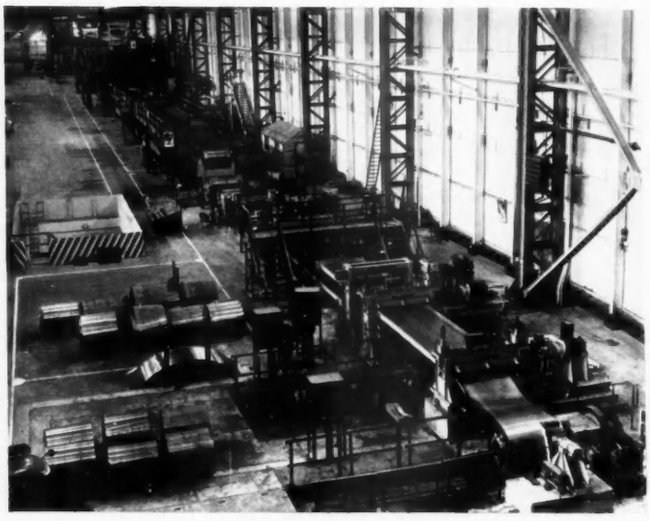


Fig. 2 General view of galvanising line from the entry point.

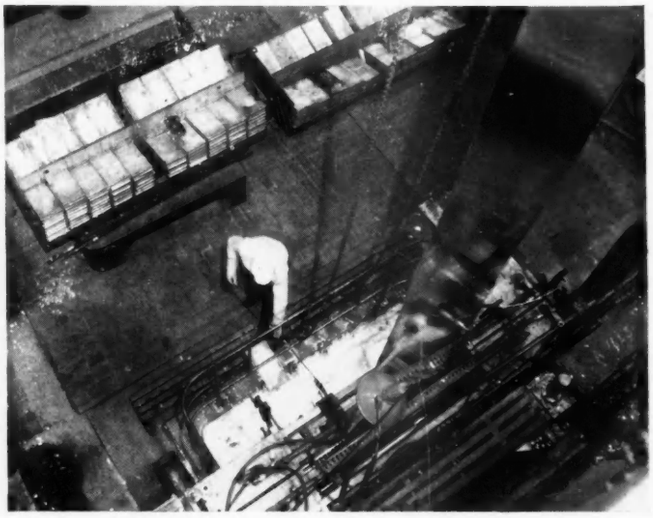


Fig. 3 Galvanised strip seen leaving the spelter bath and travelling upwards to the cooling blowers before proceeding to the delivery section. Behind the operator may be seen slabs of zinc which are added at intervals to the bath.

COMMONWEALTH OIL

The big problems with world oil supplies are largely political and geographical. The most productive fields are in the Middle East, dependent on the Suez Canal. Consumption of oil in the Commonwealth is steadily rising. How far are the Commonwealth countries capable of meeting their own needs? Total Commonwealth production has gone up from just over 4½ million metric tons in 1946 to over 36 million metric tons in 1957. The biggest contribution—about 25 million metric tons—comes from Canada.

Among other areas the biggest in terms of output is British Borneo with about 5½ million metric tons a year. All this comes from Sevia in Brunei except for a small yield from the Miri field in Sarawak. The main hope of increased production here lies in offshore exploration. A British built mobile offshore drilling platform to operate in water 150 ft deep is scheduled to go into operation at the end of the year. Trinidad, formerly the largest producer in the Commonwealth now produces about 5 million metric tons a year. Here also future plans are largely concerned with offshore development. Pakistan and India are long established oil producers. In India output was under half a million metric tons last year but it is hoped to put this up to 3 million metric tons when the Nahorkatiya-Hugrijan field is developed. In Pakistan the chief success has been the discovery of natural gas at Sui and Sylhet.

The most encouraging recent results are in the Oloibiri and Afam areas of Nigeria. Further exploration and development is going on here and in the swampy area of the Niger River. Apart from the United Kingdom itself which has an annual yield of only 80,000 metric tons a year there is no other production in the Commonwealth. Efforts to find oil are being strenuously pursued in several other regions. But while the prospects for increasing the output and known resources of the Commonwealth are good, it is likely to be a number of years before the development of indigenous supplies can affect its position as a large scale importer. This makes the considerable stake held by British interests in overseas oil production of especial value both to Britain and the Commonwealth.

shop includes a corrugating machine which is capable of dealing with up to 5 tons of sheet per hour.

Apart from the electrical and mechanical maintenance crews, the entire galvanising line is worked by six men, plus one operator who is responsible for overall control, on each shift.

The main contractors for the plant were Head Wrightson Machine Company Limited, Middlesbrough, and the furnace equipment was supplied by Birlec Limited, Tyburn Road, Birmingham, 24. The complete electrical equipment was furnished by the English Electric Company Limited, Marconi House, Strand, London, W.C.2. In all, a total of 19 Ward-Leonard d.c. drives are employed, each drive being supplied by its own generator. Full control of the line is provided by push-buttons and switches on four main desks, 22 control cabinets and numerous push-button stations.

In conclusion, some of the advantages claimed for the Armco-Sendzimir process may be cited. The fact that the expensive pickling and fluxing operations have been replaced by carefully controlled oxidation and reduction processes, with simultaneous annealing, produces a surface which gives instantaneous bonding between the steel base and the molten zinc. The absence of steam and acid and flux fumes makes for better working conditions in the shop. Furthermore, the omission of flux allows aluminium and other elements to be added to the spelter bath. The coating is guaranteed to be so well bonded, adherent and uniform that it will withstand any pressing or forming operations within the range of the steel base. It is emphasised that there is no flaking of any kind. Hence, it is pointed out that as a coated sheet may be used for pressings instead of pressing an article and galvanising it subsequently, important savings can be made. The method is recommended for such applications as bunkers, bins and buckets; gutters, ducting and washing machines; and agricultural machinery, railway rolling stock and storage tanks.

Fig. 4 Delivery section, on the ground level, where the galvanised strip is coiled or cut into sheet lengths. The furnaces are on the uppermost platform.

REFINING NICKEL FROM CANADIAN ORES

The third in a series of colour cinema films with sound commentary, produced for the International Nickel Company of Canada Limited, describes how nickel is refined. The first film explained how the Sudbury nickel ores are mined, and the second how they are milled and smelted. The new film, which was shown in London by the Mond Nickel Company Limited recently, takes over the description at the point where the smelting operations have produced nickel oxide sinter. After a brief prologue, in which the nature of the Sudbury ore is explained and a rapid recapitulation is made of the processes leading up to the production of nickel oxide sinter, the preliminary processes of melting the sinter, cleaning the slag and casting the nickel anodes are shown. Then follow detailed accounts of the processes of electrolytic and the Mond carbonyl refining methods. The recovery of pure nickel, cobalt, copper and various precious metals, and the production of a number of chemical salts and oxides are then shown.

The film, of 16 mm size, runs for 52 minutes and is available on free loan on application to the Publicity Department, the Mond Nickel Company Limited, Thames House, Millbank, London, S.W.1.

MECHANICAL TESTING OF FORGINGS AND CASTINGS

The new mechanical-testing department of William Beardmore and Company Limited, Parkhead Steel Works, Glasgow, E.1, was opened officially on 27 June by Mr. P. M. Thomas, the managing director of the firm. The new department is housed in a modern light and spacious building in Shettleston Road and it replaces the previous test house situated in an older part of the works.

At present the Parkhead Works cover an area of 70 acres and employ 3,500 persons, and the expansion of the forge, foundry and heavy-engineering facilities enables production to include steel forgings from ingots weighing up to 165 tons and steel castings of up to 140 tons in weight and of increasing complexity. The products of the firm include working and backing-up rolls for cold-reduction steel rolling mills; materials for nuclear power stations, such as blower casings, and alloy-steel plates for pressure vessels; and also turbine, rotor and other forgings for conventional types of plant.

Progress in production has depended upon similar progress in research and development and the new testing department is the latest evidence of the improvements realised in technique. The testing equipment includes a wide range of machines. Among them are two new tensile testing machines, an Avery 100 ton and a Denison 50-ton universal machine, the Avery equipment including separate tools for carrying out 180° cold-bend tests on specimens up to 1¼ in square in section. A new Losenhausenwerk Charpy testing machine has also been installed and is to be employed for conducting tests both below and above room temperature.

The production of test pieces and specimens is carried out in an extensive and well-equipped machine shop.

ARGON PURIFICATION PLANT

The use and continuous purification of a chemically-inert atmosphere is now a well-established technique at plants of the United Kingdom Atomic Energy Authority. At one time the argon atmospheres employed, when contaminated with air, were purified by passing the gas mixture over heated calcium metal. In 1953, however, the British Oxygen Company Limited devised and installed, at Harwell, a low-temperature distillation plant for argon purification. Further similar plants were built at Aldermaston in 1956, and an installation now being erected at Dounreay will be the largest of this type operated by the Authority.

In this plant impure argon at sub-atmospheric pressure and containing up to 0·2 per cent, by volume, of air is mixed with electrolytic hydrogen and compressed to about 25 lb per sq. in in a non-lubricated rotary gas compressor. By means of a re-cycling circuit, the hydrogen injection can be controlled to the stoichiometric (or correct chemical equivalent) requirements.

The gases are passed over a palladium catalyst where the oxygen impurity and the added hydrogen are converted to water. The argon, now oxygen free, is dried by refrigeration in duplicate heat exchangers. The gas is liquefied and then distilled into two fractions, namely, pure argon and a nitrogen-rich fraction which is rejected. In the process any excess hydrogen is separated and returned to the compressor suction unit. The pure argon finally passes back, through the heat exchangers, to a dry-seal gasholder for re-use. The distillation column and heat exchangers are contained in a compact thermally-insulated unit and refrigeration is provided by the evaporation of liquid oxygen.

The installation is capable of purifying 3,300 cu. ft of argon per hour and reducing the oxygen content of the gas to less than 10 volumes per million and the nitrogen to less than 40 volumes per million.

The Human Element

In a Cleft Stick

The Confederation of Shipbuilding and Engineering Unions have posed an awkward problem for the British Transport Commission. The executive committee of the Confederation at its monthly meeting last week decided to reject the Commission's offer of a 3 per cent increase to the railway shopmen. They have made a flourish of defiance to the Commission in advance of the engineering wage negotiations and put the latter in something of a difficult position at the same time.

When the railway shopmen's council meets on 21 July it will be faced with the fact that the NUR has accepted the award and the Confederation has turned it down. The NUR claim to have three-quarters of the shopmen in their union but they are in a minority on the trade union side of the council. The BTC is now faced with the alternative of displeasing either one or the other of the groups. If it tries to give an increase in the railway shop only to the NUR members there will be trouble presumably on the shop floor. The other way out for the Commission is probably exceedingly distasteful. That would be to increase the offer in due course in negotiation and thereby meet the Confederation. This would of course put the whole of the railway settlement in jeopardy.

Solid Achievement

The 10th anniversary of the National Health Service was marked by a message from the Minister of Health, Mr. Derek Walker-Smith, to the various authorities responsible for its operation in England and Wales. He contrived to do this without once mentioning Mr. Aneurin Bevan or the Government of the day 10 years ago. He made no attempt to evaluate the Service. This " new venture in the field of social welfare " could look back on " ten years of solid achievement," and to all who have contributed Mr. Walker-Smith conveyed " the sense of gratitude and appreciation so widely felt throughout the country." There was nothing else to indicate how far the NHS had made a contribution to the nation's health or social and industrial stability.

The main point in the Minister's address was his emphasis on the work done by volunteers, who serve as members of the authorities responsible for the local administration of the different branches of the NHS, " thus continuing and reinforcing the tradition which has long been a distinguishing feature of administration in this country." While few would dispute such sentiments, it is perhaps not all that could or should have been said about one of the most remarkable social experiments of our time.

Documentaries for Discussion

Seven new filmstrips have been produced by the Industrial Welfare Society for sale or hire. This brings the IWS filmstrip library up to 50.

The filmstrips consist of a length of 35-mm film and a standard gramophone record. The film consists of a series of stills round which a story or dialogue is woven. They have been developed as a means of stimulating discussion on industrial problems. The latest seven deal with human relations problems of various kinds. They pose a problem in handling people and then leave it to discussion afterwards to decide what went wrong with the way it was handled.

The filmstrips are intended to be part of a training programme. There are now three series of them. The first deals with human relations, the second with people and production and the third with training. A set to hire or buy consists of one filmstrip and one record with narrative and questions. They can be of considerable value in bringing a new style of instruction into a training programme. Despite the amount talked and written about human relations in industry it is not an easy subject to teach and the first of the series, to take only one example, could help catch the imagination and bring variety into a training subject which is not always as fascinating to trainees as personnel departments would like to think.

Managers in the Making

A recent announcement from the Polytechnic, Regent Street, London, indicates that the new residential courses for senior managers they are holding in association with the British Institute of Management are now firmly established. Two courses have been completed and very good support is forthcoming from British industry. Already 33 organisations have made nominations or reservations, including 12 engineering companies. As is so often the case when courses of high quality are being organised, the support comes first of all from companies who lead in the field of management research, who have for many years taken an active part in BIM activities or employed management consultants to perfect their own management organisation or training techniques. George Angus, Bristol Aeroplane, Cementation, the Central Electricity Generating Board, Coopers Mechanical Joints, J. H. Fenner, the Lucas Group, Metal Box, Solartron, Vauxhall Motors and Wilmot Breeden sent the participants from the engineering industry.

The courses are held under the name BIM-Polytechnic Executive Programme three times a year, each lasting some 25 days. The programme has been carefully designed " to give managers the opportunity to practice executive skills in a very broad setting." The formal teaching programme will concentrate on discussing some of the new developments in management theory and management practice, recent research findings and the experience of successful managerial methods in various countries.

The main subjects treated during the course are organisation and administration, management techniques, personal relations, management control, marketing and communications. The programme will stress the importance to successful senior managers of " seeing each technical and administrative function as a contribution to the effectiveness of the whole organisation " and the need for " adaptability to change." The emphasis is being placed on taking the broad view and looking ahead. The programme is a very useful half-way between the short 2 to 3 day seminar (as held by BIM) and the three months at the Administrative Staff College. Both the length of the stay and the cost of the course (100 guineas plus 65 guineas hotel accommodation) are well within the means of the medium-size firm and the programme should therefore be well supported. The eighteen places, filled from nominations by firms, may well prove inadequate provision for industry's requirements.

Grants for Research

The value of awards for DSIR students receiving post-graduate training in science and technology will be increased by 10 per cent as from 1 October. Students living in college in London will receive £420 a year, compared with £380 at present, and those living with their parents £285, compared with £260. The value of DSIR research fellowships will also be increased at the same time, the present scale of £600 to £800 a year rising to £700 to £850.

The extent of DSIR's sponsorship of post-graduate education is substantial. Some 2,000 students will benefit from the increases in the autumn. The major part will be research students who have been awarded two to three years of post-graduate training in methods of research. The research fellowships are awarded to young investigators of outstanding ability already trained in methods of research, and the advanced course studentship to graduates who wish to pursue " acceptable post-graduate courses of instruction where these are not in research methods." The increases are in accordance with a policy of keeping up the purchasing power of the grants and as such almost an annual affair.

Worth Their Weight in Dollars

Slump or no, the pay of engineers is rising steadily in the United States. Useful statistics on this and related subjects were published recently by the Technological Institute of Northwestern University, Evanston, Illinois. The average salary accepted by the 96 men who received bachelor's degrees in engineering in 1958 averages 505 dol a month, which compares with 480 dol a year ago and 432 dol in 1956. The average starting salary accepted was highest in " science engineering " at 550 dol, followed by industrial engineering (511 dol), civil (510 dol), electrical (508 dol), chemical (500 dol) and mechanical (496 dol). Of the 1958 engineering class, 42 per cent plan to enter industry, while 25 per cent plan full-time graduate study. Fifteen per cent will enter the armed forces, 3 per cent will combine school and industry and 15 per cent are still undecided.

A sign of the times was the decline in the number of interviews each student was granted and in the job offers he received. In 1957 the figures were 10 interviews and six offers: this year the average was only 6 interviews and 1·8 offers. In many ways this is a much healthier state of affairs, but it may not remain as favourable. Most industrialised states have come to realise, albeit very slowly, that the tremendous emphasis placed on the need for technologists in industry went too far. The need is very great but not perhaps very far ahead of available supplies.

Tact and "Take-Over"

The disclosures that the Amalgamated Tobacco Corporation Limited has made a bid for the shares of the London Crematorium Company Limited, which owns the Golders Green and one other crematorium, has created a certain amount of stir. In objective terms, there may be no more to it than that the crematorium company has paid conservative dividends over a period of years which have made it a likely target for a " take-over " bid while the tobacco company wishes to broaden its interests.

Timing is everything in this world, however. At a time when the connection between tobacco and lung cancer is being actively debated the tobacco company inevitably lays itself open to attack. It also becomes liable to be the source for the sort of macabre jokes which are better received north than south of the Tweed. There is clearly ample scope all round for either a lack of humour or a misplaced sense of it. So far as the public is concerned, it is up to the tobacco company to decide whether it is prepared to attract a certain amount of illwill by pursuing the deal or whether to let the matter drop. There is no need for shocked remarks from the crematorium company. The matter altogether has a great deal more to do with a perfectly legitimate commercial arrangement than the sanctity of the dead.

Marketing

COMPROMISE ON EUROPEAN FREE TRADE

The main problems included in the establishment of a free trade area in Western Europe are discussed in a recent broadsheet published by Political and Economic Planning (Planning No. 423, 2*s*. 6*d*.). The authors of "Problems of Freer Trade in Europe" conclude that a free trade area is a "more difficult concept to apply than it appeared to be when first proposed" and that if agreement is reached, "the result will not be a tidy arrangement, and it will be founded on compromises." Nonetheless they see in the proposals a basis for a new relationship between the United Kingdom and the Continent of Europe.

PEP refer to the working parties of OEEC who have thoroughly explored the technical problems of establishing a free trade area. Enough possible solutions have been devised, they say, to enable agreement to be reached quite rapidly "if there were a real meeting of minds among the negotiating countries on certain basic economic and political questions." The Treaty of Rome is described as "a political conception with political antecedents." The decision of the six countries to form the Common Market was taken with the full realisation that the end of the road may be political unity. In fact little else is possible in the circumstances, although this very consciousness—in some quarters it is a fear—has probably done more to retard progress towards agreement on a free trade area than any other factor. The British views set out in the White Paper indicate that the motives behind the Government's interest are largely economic. Time may show that the British approach is the right one, and that economic unity is a promising first step.

PEP are about to embark on a major study of the relationship between Britain and the European Community, for which they have obtained a substantial grant from the Ford Foundation. Specific research topics will be chosen from seven main fields of study, which include internal trade and tariffs, external trade and tariffs, effects on industry, and labour questions. This study should add considerably to our knowledge of the subject and be a useful complement to other studies already published. Occasional papers and reports will be published as the programme progresses, and it is probable that a close liaison will be maintained with the powerful Britain-in-Europe Committee formed recently by leaders in industry and commerce. (See Weekly Survey, 11 July, page 34.)

Foothold in Europe

Scepticism concerning the successful outcome of the negotiations now going on for the establishment of the European Free Trade Area is leading some companies to take out an insurance policy in the form of an investment in Common Market Industry. Cockburns Limited, of Glasgow, have formed a subsidiary at Sibiedam in Holland to make their safety and relief valve for gas and fluid service. Originally intended to service and repair Cockburn valves in Europe, the subsidiary is now aiming at capturing a large share of the market, encouraged by a lively European demand for the parent company's products.

Black and Decker, Limited, have established a new organisation in Holland, Belgium and Germany "to expand Black and Decker electrical tools sales and service in the European Common Market." The company say that they attach the greatest possible importance to this move and that they intend to develop the market "from within—not from the United Kingdom or the United States."

Increasingly it is becoming evident that whatever results from the political moves to integrate European industry, or from the general world trend towards freer trade, British industry's stake in Europe is getting larger and requires a foothold across the Channel. Nothing will lead to quicker results or closer integration than financial links between companies or the establishment of subsidiaries in Europe (or vice versa). It will soon become a race, and early starters have a good chance of going very well.

Progress with New Zealand

Twelve weeks of negotiations between the British and New Zealand Governments for the revision of the Ottawa agreement have produced no agreement and none is in sight. New Zealand is seeking a reduction of the preferences accorded to the United Kingdom to 7·5 per cent for some goods and 10 per cent for others, compared with the basic 20 per cent preference at present in force (higher in some cases). The argument is that the high preferential tariff is hindering New Zealand in her trade negotiations with other countries.

The New Zealand Government have good cause for taking up their stand. There's is a free trade argument which must accord with the views so often expressed by Mr. Macmillan and his colleagues. Sooner or later advances will be made towards freer trade and the United Kingdom is unlikely to be the loser. It may well be a condition of participation in the European free trade area. Basically it is in line with the policy of the Government and with the current trend in world trade.

British manufacturing industry must view the proposals with some concern, since the time is coming when competition with Germany, Japan and others could dislodge many British exporters from Commonwealth markets. But the crucial factor in the next few months is likely to be physical restriction rather than tariff levels. Already the motor industry is preparing for a major cut in car exports to the Commonwealth.

Russian Market for British Skills

There is a growing belief among British precision engineering companies that a market for their products exists in the Soviet Union. The intensive drive in Soviet factories towards the maximum possible automation—aimed primarily at ensuring quality standards and reducing requirements for skilled labour—has created a very large demand for high precision equipment. With this in mind, Mr. V. A. Kennett, joint managing director of Plannair Limited, left this country for Moscow recently.

Plannair consider that their axial flow and centrifugal blowers and compressors will find applications in Russian aircraft and electronic equipment, on the grounds that they are further advanced than anything so far produced in Russia. Others who have been leading suppliers to the British aircraft industry may come to the same conclusion as Plannair. The Russian market could absorb a substantial capacity for the quality high precision products the aircraft components industry is so well equipped to supply. Unfortunately, not every company can send a chief executive who speaks fluent Russian as Mr. Kennett does.

Specialised Selling

American businesses have learnt from the recession that sales drive and effectiveness are at a premium as never before. Companies are rapidly re-organising to increase their market penetration power and are undertaking more and more promotional work. ALCO Products Inc., Schenectady, N.Y.—known to the world as the American Locomotive Company, but now a large well diversified engineering group—have evolved separate sales divisions for each of their main product groups. The aim is to provide more specialised sales direction and selling efforts in the field. Their vice-president for marketing, Mr. W. F. Lewis, explained that this was "a natural outgrowth of the decentralisation announced in October, 1956, at which time ALCO's transportation, spring and forge, thermal, and petroleum industry equipment divisions were formed."

This is a reversal of a trend towards the centralisation of marketing activities which was born and gathered momentum in the post-war period of sellers' markets. It is based on the belief that the less you give a salesman to sell, or a sales manager to administer, the more likely he is to sell well or to administer effectively. It is a trend which can hardly fail to intrude in British industry, when the move towards centralised selling is still gathering momentum.

Prices and Politics

The universal trouble of nationalised industries the world over has emerged with alarming suddenness in coalmining. Traditionally—perhaps because nationalised industries have always been those which supply a public service, such as transport or power—prices have been fixed to secure the maximum public acceptance and goodwill. So have the nature and scope of the services rendered. British Railways ran for many years, even before nationalisation, lines which were hopelessly uneconomic but socially desirable. Now it is coal's turn. The Minister of Power has told Tory back benchers that the Government had the whip hand in price policy, not the National Coal Board. Much the same is happening in electricity and gas. The same happened not very long ago in the fixing of rates.

Now the National Union of Mineworkers has taken up the challenge. Their president, Mr. Ernest Jones, told their annual conference that the union would not agree to Lord Mills' statement about the continuation of the "gentlemen's agreement" through which coal prices cannot be raised without the agreement of the Minister of Power. Mr. Jones is worried about the trend of demand for coal. Large household coal is in short supply and so is smokeless fuel. Small coal is abundant and lies in heaps. Why not adjust the prices to meet the demand. Many will sympathise with Mr. Jones, though not perhaps with his renewal plea for subsidies. If we allow politics to affect price levels in the nationalised industries producing raw materials the consequences may be hard to control.

TV in Sales Promotion

London Press Exchange have, through their subsidiary L.P.E. Television Limited, commissioned Marconi's Wireless Telegraph Company with the planning, engineering and installation of a most elaborate system of closed circuit television and telecine. As many as 43 offices, including three conference rooms, will be wired to use the facilities provided. Any executive in the company can audition artistes without leaving his office and see them exactly as they would appear in a TV advertisement.

The company's clients are similarly placed. They can assess accurately the screen appearance of a product just as it would be seen by the viewer at home. This eliminates the risk (present in most cases) that packaging designed for attractive display in shops will not reproduce well in the black and white medium of the television screen. The installation is an advance which had been forecast for some time by the principal manufacturers of closed circuit television.

Research and Development

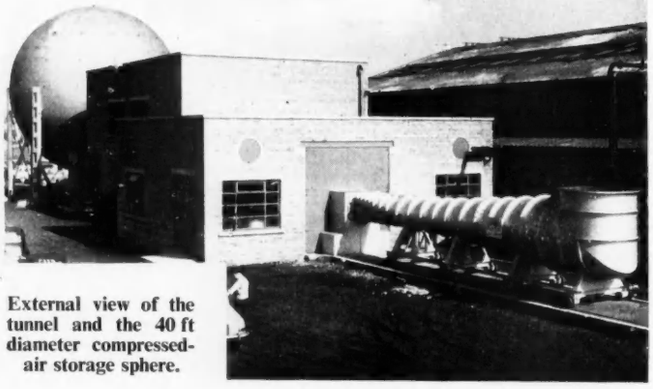
AVRO'S BLOW-DOWN WIND TUNNEL

High Reynolds Number at Mach 3·5

At the Woodford, Lancashire, works of A. V. Roe and Company Limited, an intermittent supersonic wind tunnel has recently been put into operation with a speed range from Mach 1·6 to Mach 3·5. The working section, in which models up to 30 in long can be tested, measures 30 in by 27 in. This new " blow-down " tunnel is believed to be the largest tunnel in western Europe operating at such high Mach numbers—and the only one at present in operation at which Reynolds numbers can be obtained as high as 1×10^6 per inch at a Mach number of 3·5 (about 2,300 m.p.h.). Because of the short duration of the run—40 sec—the operation of the tunnel and the recording of the pressures, loads and moments on the test model are completely automatic.

The intermittent type of wind tunnel, which is supplied by air from a large pressure vessel over a very short period, is much less costly to build and to run than is the continuous flow type of supersonic tunnel, inevitably a highly complex and power-consuming plant. In the Avro installation, the compressor power to charge the pressure vessel with cooled, dried air, amounts to only 420 h.p., and yet the equivalent power in the tunnel is more than 100,000 h.p. It takes from 70 to 120 min to pump up pressure in the storage vessel—and, as already stated, the stored energy is dissipated in 40 sec.

To offset the limitation in running time, the blow-down tunnel has several distinct advantages as compared with continuous-flow tunnels: because there is no compressor to be damaged in the actual tunnel circuit, models can be allowed to break up—and so flutter tests, simulated jettison of boost rockets, or bomb-dropping tests can be safely carried out. Another inherent advantage is the high Reynolds numbers that can be obtained with relatively small models.



External view of the tunnel and the 40 ft diameter compressed-air storage sphere.

In the Avro supersonic tunnel, the stagnation pressure is variable, so that Reynolds number can be varied independently of Mach number. A flexible nozzle precedes the working section, allowing what is effectively infinite variation of Mach number over the range 1·6 to 3·5. The most unusual feature of the tunnel is the retraction of the model from the working section to avoid the very severe air loadings that occur at the higher speeds during starting and stopping.

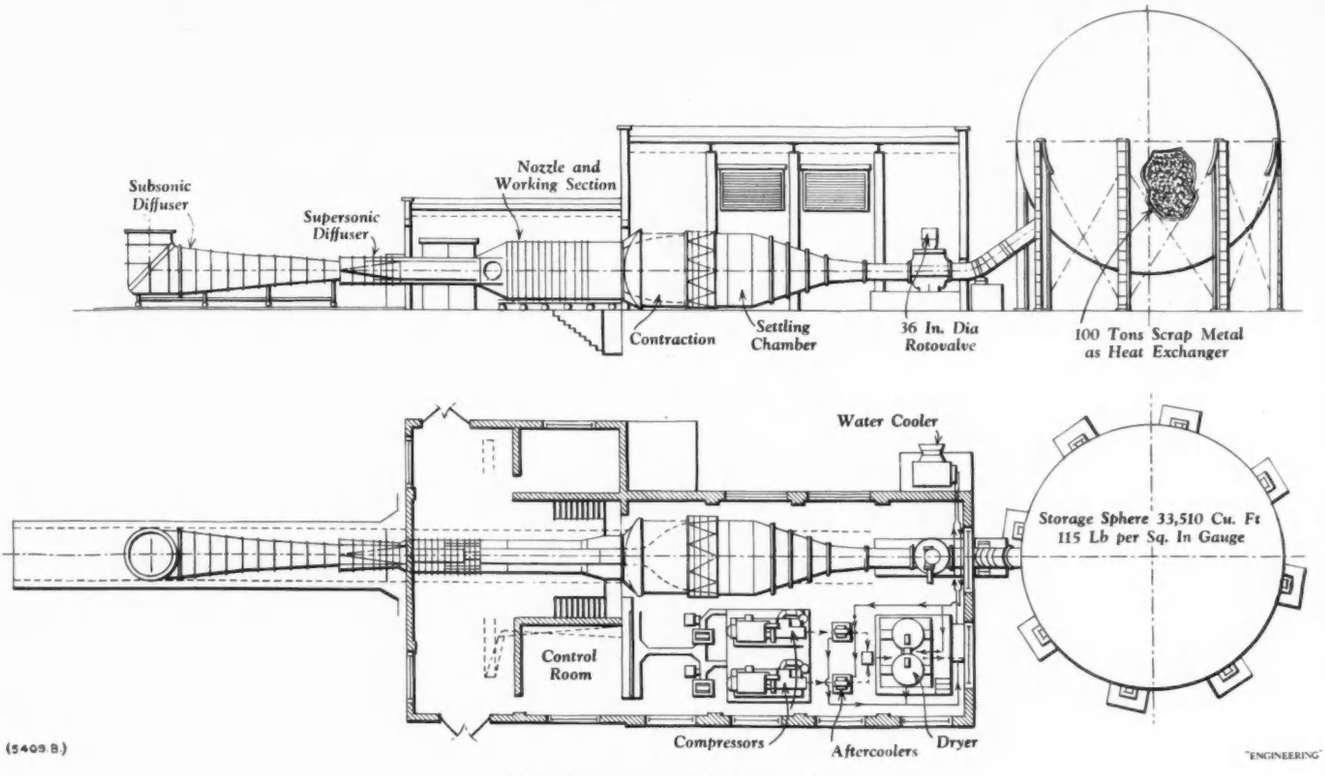
SCRAP-METAL HEAT EXCHANGER

In the illustration on the left can be seen the Whessoe pressure vessel, a 40 ft diameter welded sphere with a capacity of 7¾ tons of air at the storage pressure of 115 lb per sq. in (ENGRG, vol. 182, 1956, p. 190). During tunnel operation, it is necessary to counteract the temperature drop due to the expansion of the air in the pressure vessel, and for this reason an unusual type of heat exchanger is housed within the sphere. It comprises 100 tons of clean scrap metal from Avro's press shops, mostly 20 s.w.g. steel sheet, stacked in random fashion, and having a matrix density of 6·7 lb per cu. ft, and a surface area of 315,000 sq. ft. By this means the storage air temperature is stabilised to within 10° C under all running conditions.

The air which charges the storage sphere is supplied by two Broom and Wade two-stage compressors of 1,000 cu. ft per min capacity, shown opposite. Most of the water content of the air is removed by compression and subsequent cooling, and any residual water vapour is then extracted by passing the cooled air through a duplex activated alumina dryer. Pressure is maintained at 100 lb per sq. in throughout the cooling and drying system by a surplus valve.

AUTOMATIC TUNNEL REGULATION

A combined cut-off and pressure-reducing valve controls the discharge of air from the sphere through the wind tunnel. The valve, a 36 in diameter Harland Rotovalve, is hydraulically operated and servo-controlled, and takes 2 sec to open fully. The servo system permits any desired stagnation pressure to be set up and



General arrangement of the tunnel.

held to within 0·5 lb per sq. in throughout the tunnel run. The cut-off valve forms the sole anchoring point for the tunnel; the remainder of the tunnel structure is supported on rollers on a track, to allow for thermal expansion.

After passing through the Rotovalve, the tunnel air enters a settling chamber of 11 ft diameter, where the flow is smoothed by a perforated steel plate followed by three fine-mesh gauze screens. Transition from the circular cross-section of the settling chamber to the rectangular supersonic nozzle is effected in the contraction section by light-gauge plates. The loads on the plates are transmitted to the main cylindrical pressure shell by filling the annular space with oil, thermal effects being eliminated by providing a header tank and bleed.

The nozzle section is formed by two fixed-contour throat blocks and flexible steel plates, 0·45 in thick, on the top and bottom walls; the side walls are fixed and parallel. The blocks and plates are supported on 13 pairs of double-ended screw-jacks through links and crossheads. To vary the nozzle shape, the screw-jacks are driven by rotary solenoids, through reduction gearing, giving increments of 0·002 in, sequential signals being fed to each jack station. The nozzle-movement programme is set out on punched teleprinter tape, which is fed through a tape reader to the control gear; the programme is arranged to give increments in Mach number of 0·01 between Mach 1·6 and 3·5.

The working section itself is fitted with 22 in diameter schlieren windows; 18 in mirrors are provided, and both continuous and spark-source illumination, so that the model and shock system can be observed visually throughout the run. In the working-section floor is a well into which the model is retracted during starting and stopping. To give access to the model, the tunnel can be broken between the working section and the supersonic diffuser by hydraulic jacks, which move the whole of the diffuser downstream on its roller track.

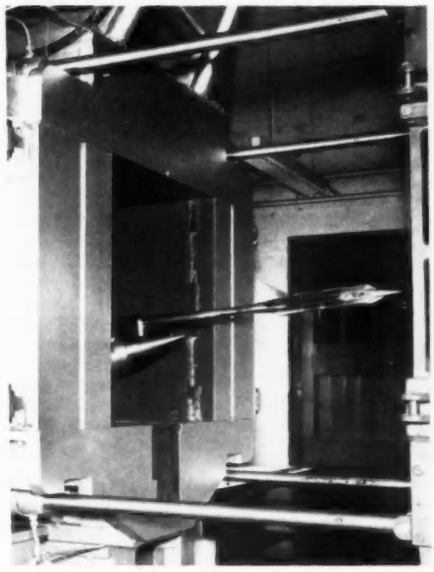
The supersonic diffuser is of simple two-plate design, permitting the tunnel to run at a lower pressure ratio once supersonic flow is established; it is not adjustable during the run. Housed in the diffuser section is the model support and incidence gear, hydraulically operated, which allows translational movements of the model without incidence change, and also allows incidence change at any fixed position in the tunnel. By this means the largest possible model can be used, under all conditions of incidence and yaw, with freedom from reflected tunnel shocks.

From the supersonic diffuser the tunnel air passes to the circular-section subsonic diffuser, 40 ft long, and thence to atmosphere; a 90° elbow is provided at the downstream end to relieve the ductwork of axial thrust, as well as for safety reasons.

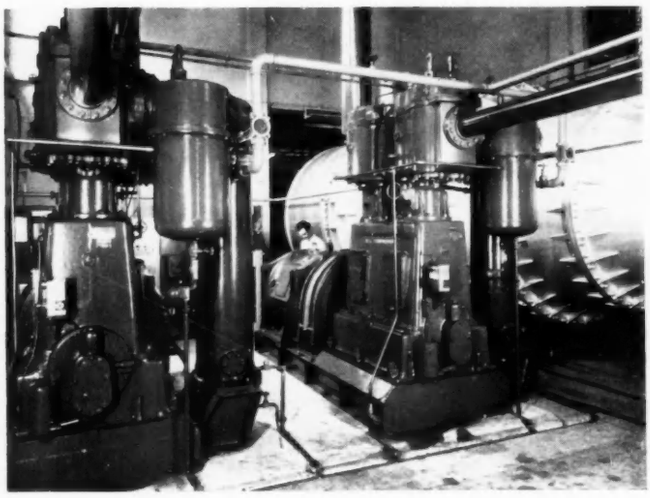
DATA HANDLING AND PROGRAMMING

High-tensile steel models are used to withstand the heavy loadings. The forces and moments are measured by sensitive strain-gauge balances housed within the model. The signals from the strain gauges are transmitted to self-balancing potentiometer recorders. The data is presented both visually on recorder charts, and in the form of punched tape for feeding to a Ferranti digital computer for reduction: each information channel being fitted with a digitiser disc, the output of which is fed to a neon-tube store. At pre-determined intervals in the test programme, the store is "frozen" and scanned, and the information is punched on to teleprinter tape.

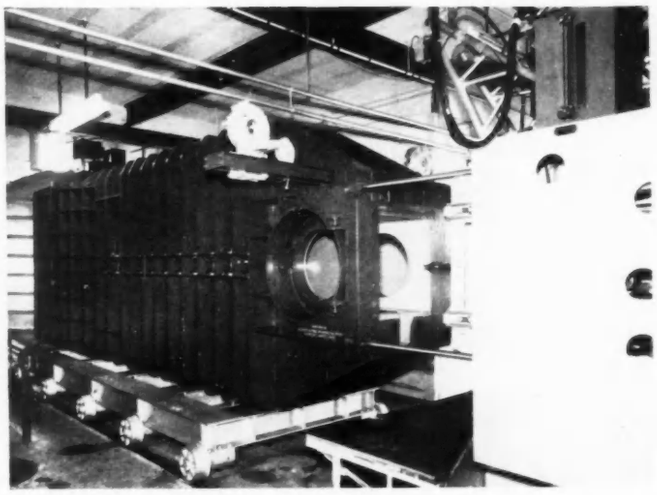
As stated earlier, the whole tunnel operation is automatic. Before a run starts, the nozzle is set to give the desired Mach number, and the servo-systems controlling the stagnation pressure, length of run, model incidence programme, etc., are set up. On initiating the main-valve servo, the following events take place: (1) the valve opens at the maximum rate to a pre-determined position for initiating the required supersonic flow. (2) The valve then opens gradually, following a hyperbolic curve as the storage pressure falls, and thus maintaining the preselected stagnation pressure. (3) Final trimming is obtained by a closed servo loop monitored from pressure errors from the preset value measured in the settling chamber. (4) A time-delay control triggered by the stagnation pressure raises the model from the well into the working section, and initiates the preselected incidence programme. Safety interlocks ensure that the main valve cannot be closed until the incidence programme is complete and, at the higher Mach numbers, the model retracted back into its well.



To provide variable yaw, the model and sting are mounted on a cranked support.



The compressor house; the tunnel settling chamber is in the background.



A break between working section and diffuser gives access to the model.

HIGH VOLTAGE TREND

At the recent Conférence Internationale des Grands Reseaux Electriques (CIGRE) mention was made of a 750 kV experimental transmission line to be built in the United States. Some more details of this are now available. The line will be 4½ miles long and will have steel reinforced aluminium conductors with spans between towers from 800 to 2,200 ft. The constructors are the General Electric Company of America and the line will be built in sparsely settled country near Pittsfield, Mass. It will eventually be incorporated in the Western Massachusetts Electric Company's system.

The line will be energised in 1960 at 460 kV and then tests will be carried out at successively increasing voltages up to 750 kV. The line has a rating of 40 MVA.

This new line is another step in the advance towards higher transmission voltages with the economies that they offer in material and capacity. Also at the CIGRE conference the Russians gave some details of the 500 kV line that is operating at Kuibishev and stated that they hoped to have all their long distance lines working at 500 kV within the next two years. They already have experimental lines operating up to 650 kV.

A word of warning was inserted at CIGRE that above some particular voltage the savings in material might well be outweighed by increased costs of construction. It would be a great pity therefore to see a technical trend to higher voltages, started because of the economies possible, develop into a race to record high numbers.

Continuing **Research and Development**

SLIPPING-CLUTCH FATIGUE-TESTING MACHINE*

Development of 1,500 lb Unit at N.P.L.

By N. B. Owen, A.M.I.MECH.E. *and H. L. Cox,* M.A., F.R.AE.S., A.M.I.MECH.E.

The construction and operation of a 1,500 *lb direct-stress fatigue-testing machine operated by a slipping clutch are described in the present article. Several versions of this machine have been in operation since* 1950, *and a* 10-*ton machine working on the same general principle was described in* ENGINEERING, *vol.* 179, *page* 500 (22 *April*, 1955). *The* 1,500 *lb machine now in use at the National Physical Laboratory, however, incorporates several features which have not previously been reported.*

An obvious means to apply a direct load to a test piece T is to compress an ordinary helical spring S; by the use of a conventional crank and connecting rod driven by a motor D a cyclic pulsation of compressive load is achieved. If the connecting rod is made long in relation to the crank, uniform rotation of the crank results in substantially sinusoidal vibration of the spring and, moreover, the little-end bearing is then conveniently replaced by a flexible strip (Fig. 1a). To provide alternating load while still using ordinary compression springs, and at the same time to free the drive D from mean load, a pair of springs S_1 and S_2 is used, compressed back to back within a loading frame L (Fig. 1b). With this arrangement the drive D has still to transmit the range of load, but this dynamic load in the drive is annulled by adding between the springs a mass M so chosen that at the desired speed of operation it resonates on S_1 and S_2 (Fig. 1c). At starting of this system the drive D has still to transmit the full range of load, but this is avoided by fitting a clutch C between the piston of the drive and the mass block M; in order to accommodate the clutch the spring pair S_1 and S_2 is duplicated (Fig. 1d). For the application of mean load to the test piece two more pairs of springs S_3 are interposed between the loading frame L and the machine frame (Fig. 1e). By a correct choice of the stiffnesses of the two sets of springs in relation to the mass of the loading frame the load range imposed on the test piece is rendered virtually independent of its own stiffness.

* Communication from the National Physical Laboratory, Teddington, Middlesex.

The main frame F is then completed round the whole assembly, a slidable top cross-head being provided to accommodate test pieces of different lengths (Fig. 1f). In order to prevent all relative movement of the mass block M, the loading frame L and the main frame F, except along the axis of loading, the mass block M is arranged to slide along guides G built into the frame L and this frame itself is supported on parallel flat strips P stretched transversely across the main frame by lever fixings H (Fig. 1g). In order to balance the vibratory momentum of the mass block M another mass N is mounted on springs from the main frame F and tuned to resonate at the operating frequency, while the main frame itself is stood on rubber pads R on the floor (Fig. 1h). Vibration of the mass N in antiphase to the mass block M is automatically excited, and the vibration of the light frame F itself is thereby kept small enough to permit the drive D to be mounted directly upon it, while at the same time no appreciable vibration is transmitted to the floor.

Finally the machine is completed by the addition of a screw mechanism to operate the static loading springs; of a double eccentric to adjust the throw of the crank E and to maintain internal balance in this unit; of two cut-outs, one which operates whenever the clutch slips and the other when the test piece breaks or deforms excessively; and of stops to prevent too large a movement of the loading frame L after fracture of the test piece.

CONSTRUCTION

A photograph of the small machine constructed at the N.P.L. according to the principles described above is shown in Fig. 2. It is driven by a direct-current motor at about 3,000 cycles per min and the maximum load range available, corresponding to the full crank throw of $\pm \frac{3}{8}$ in, is just under 2,000 lb.

The main frame of the machine is constructed of four 2 by 2 in angles erected vertically on a base channel cross member which carries the driving motor and variable-throw crank assembly. A second channel cross member immediately below the loading frame houses the cross-head bearing for the piston end of the connecting rod and also accommodates the screw gear by which tensile static load is applied. The third cross member at the top of the frame is of box section, and the upper loading head, which is also of box section, is suspended from this cross member by a central screw; two round rods rigidly attached to the loading head are arranged to slide through closely fitting housings in the top cross member and these serve to preserve the alignment of the loading head and to prevent its rotation. The lower loading head is attached to the top of the loading frame immediately above the upper transverse supporting strip. In Fig. 2 the test piece shown in position consists of a flat plate tested under alternating bending. The loading frame is constructed of two transverse members of box section held together by long bolts which serve also as guides for the mass block which slides on them.

In the N.P.L. machine the mass block is provided with phosphor-bronze bushes set in rubber and these bushes slide on mild-steel bolts; continuous lubrication is not needed, but the slides are oiled at least once daily. Sintered brass bushes are also satisfactory, provided always that they are set in rubber mountings, and it is probable that ordinary brass bushes would also prove satisfactory if mounted in rubber. Without the rubber mountings continual trouble was experienced with wear and scuffing of the slides, and no improvement in lubrication nor surface treatment of the slides effected a permanent cure.

The parallel strips by which the loading frame is supported from the main frame are secured to the former at their centres through distance pieces which hold the strips clear of the top and bottom surfaces of this frame. Each end of each strip is bent up at right angles and secured to the outer surface of a flat plate, which on its inner surface is scored transversely by a V-groove. This groove registers with a pin held in a similar V-groove scored across a bracket on the main frame, and the plate is also attached to the bracket by three screws disposed across its width on the side of the pin remote from the transverse strip. By tightening the screws the plate is caused to rock over the

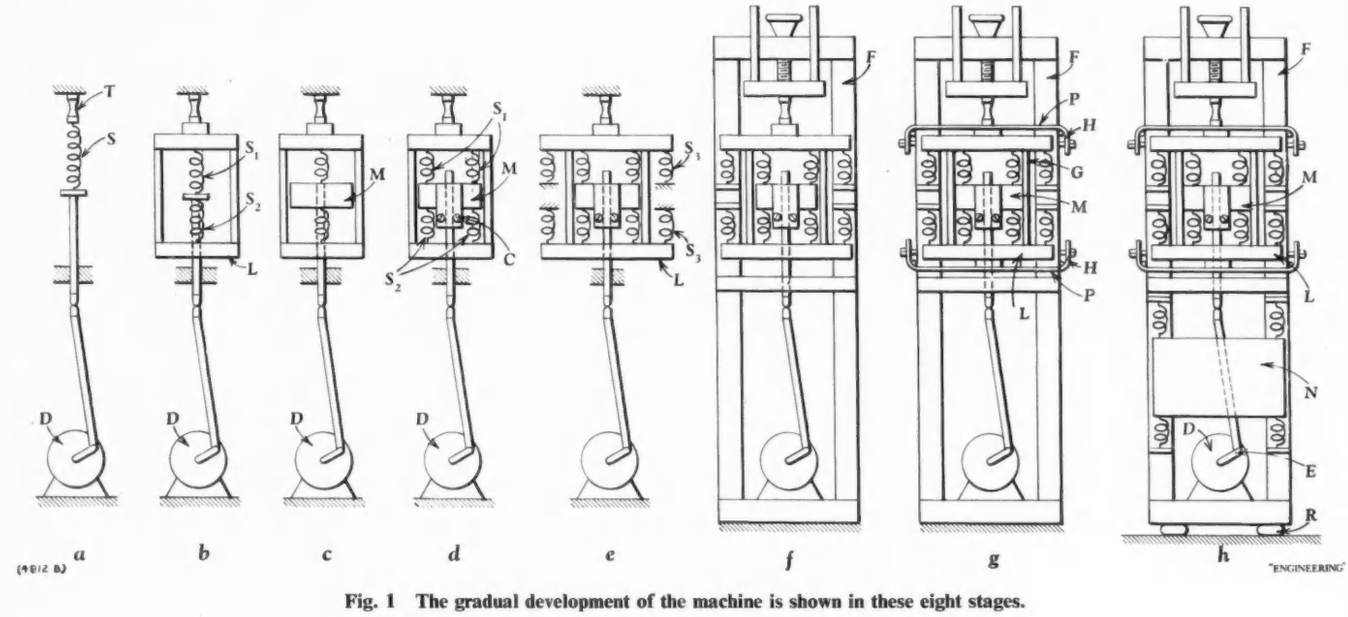


Fig. 1 The gradual development of the machine is shown in these eight stages.

pin and the strip is stretched. Moreover, by slackening on one side and tightening on the other the whole strip may be moved laterally, and thus the alignment of the machine in this plane may be adjusted.

The clutch consists of two pieces of Tufnol each 2 in long, attached by leaf springs one on either side of the mass block. Semi-circular grooves are scored down the centres of the inner surfaces of the clutch and the two halves are clamped round the piston portion of the connecting rod by means of two bolts, one on either side. The clamping pressure is controlled by tightening wing nuts by hand against spring washers.

The driving shaft is carried in plain journal bearings in a U-shaped housing bolted to the bed of the machine, and this shaft is driven through a pin and disc coupling by a $\frac{1}{2}$ h.p. direct-current motor mounted on the same bedplate. The outer end of the driving shaft is reduced to a pin $\frac{5}{8}$ in in diameter and $\frac{3}{16}$ in eccentric from the inner journal, and on this pin are mounted two bushes having the same eccentricity. The big end of the connecting rod, which is a standard small motor-car engine unit, is mounted directly on the inner bush, while the outer bush, keyed to remain coaxial with the inner journal, itself forms the outer journal. The throw is varied by rotating the inner bush round the eccentric pin and the assembly is clamped together by a nut on the outer end of the driving shaft. Both shaft and eccentric are separately balanced so that balance is maintained at all settings of the throw. Both journals and big-end bearings are pressure-lubricated by oil supplied by a pump mounted on the tail end of the motor shaft.

The machine is fitted with three cut-out switches, one which stops it when the test piece fractures or stretches unduly, another which stops it whenever the clutch slips, and a third which stops it if the oil supply should fail. Stops are provided to limit the movement of the loading frame when the test piece fractures and thus to prevent subsequent damage to the fractured surfaces.

OPERATING EXPERIENCE

When the motor is started the connecting rod slips in the clutch until the motor speed approaches the resonant frequency of the mass block on the dynamic springs. Then the clutch friction is sufficient to excite the mass block and to maintain it in vibration, without further slip at the clutch, at an amplitude determined by the throw of the crank. The magnitude of the range of load imposed on the test piece is computable as the product of the amplitude of motion of the mass block and the known stiffness of the dynamic springs, but the dynamic stiffness of these springs exceeds their static stiffness in the ratio $\left(\frac{r\,\pi}{\sin r\,\pi}\right)$ where r is the ratio of the speed of the machine to the first surge frequency of the spring itself. In the N.P.L. machine this increase of stiffness is about 10 per cent. The calibration of the machine, using a weigh bar with electrical resistance strain gauges, indicated that the factor was 1·12 and, on this basis, the measured loads agreed with the computed values within ± 1 per cent of full-load capacity.

Control of load range in a direct-driven machine is essentially limited by the clearances in the bearings of the drive. If the motor setting is too high and the motor is trying to run fast, the connecting rod tends to be overthrown to the full extent of these clearances, whereas if the motor setting is low and the motor tries to run slow the clearances may actually detract from the throw. It was for this reason that the present N.P.L. machine was fitted with plain bearings pressure-lubricated in order to test whether effectively closer clearances could thus be achieved than with the ball bearings used in another model.

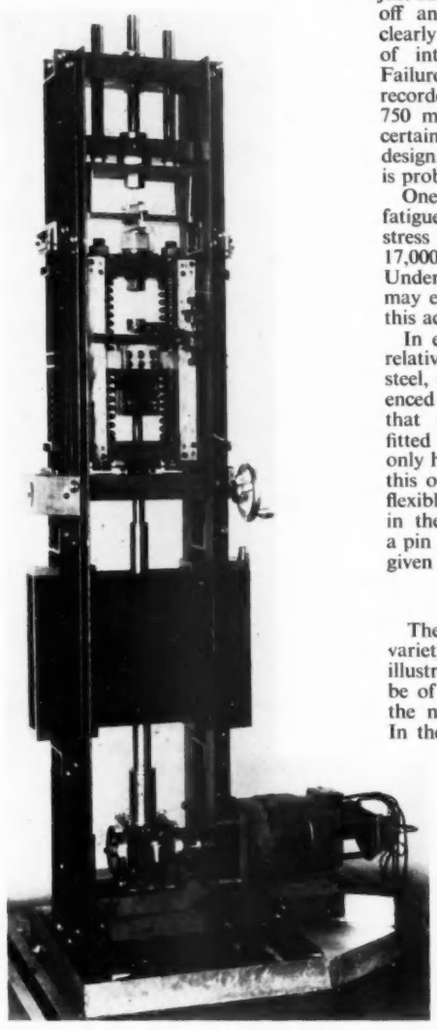


Fig. 2 The test piece shown in position is a flat plate which is being tested under alternating bending.

Experience has shown that plain bearings confer no worthwhile advantage, the total effective clearance being about 0·004 in, which is about the same as in the other model.

The N.P.L. machine has run about 800 million cycles and apart from wear and scuffing of the slides before the bushes were mounted in rubber the only failures of main components experienced have been of the dynamic springs. Several have failed by fretting fatigue at the end coils; usually just the last inch or so of the end coil has broken off and the origin of the fracture has been clearly marked by fretting corrosion at the point of intermittent contact with the next coil. Failures after 20 million cycles have been recorded, but other similar springs have endured 750 million cycles unbroken. The problem is certainly related to the fine detail of the end-coil design, and by close attention to this detail it is probably avoidable.

One or two springs have failed by ordinary fatigue in the working turns. The range of stress at full load in the dynamic springs is 17,000 lb per sq. in to 68,000 lb per sq. in. Under this range of stress slight surface flaws may exert a dominant influence, and perhaps on this account, the choice of material is important.

In every case the springs which failed after relatively short endurances were of plain-carbon steel, whereas only one failure has been experienced with a chromium-vanadium spring and that after 700 million cycles. Another user fitted plain-carbon springs throughout and has only had one spring failure. On the other hand, this other user has had so many failures of the flexible strip used in place of a little-end bearing in the connecting rod that he has reverted to a pin bearing. At the N.P.L. this unit has never given any trouble.

RANGE OF TESTS

The N.P.L. machine has been used for a wide variety of tasks, of which the bending test illustrated in Fig. 2 is fairly typical. It will be of interest to make some allusion to one of the more unusual tests made in the machine. In the course of development of a torquemeter for measuring the twist in a ship's tailshaft a rather unusual failure was experienced. This failure was of one of the attachments by which the instrument was fastened to the shaft. This attachment consisted of a hard steel point located under moderate pressure in a dimple in the surface of the shaft. Under conditions of rather severe vibration the attachment broke away and on examination it appeared that the hard steel point had fractured by fatigue or by fretting corrosion leading to fatigue. Tests were made in an attempt to reproduce this type of failure and the results obtained will be reported in a subsequent article.

The hard steel point was located in a dimple in one face of a mild-steel nut and was held in position by a spring-loaded yoke encircling the nut and bearing against a hard steel ball located in a dimple on the opposite face of the nut. The fatigue testing machine was used to apply shear loading to the hard steel point only through a plate offset $1\frac{1}{4}$ in from the centre line of the machine. Under this very eccentric loading the machine ran perfectly without any appreciable lateral movement at a range of load of ± 300 lb. The rigidity of the parallel motion of the loading frame on the strips is so high that there was no reason to doubt that this fixing would prove satisfactory, but there was less reason to expect that the upper adjustable cross-head would meet this severe test so successfully.

Acknowledgments.—The work described has been carried out at the National Physical Laboratory as part of the research programme of the Mechanical Engineering Research Board of the Department of Scientific and Industrial Research. The article is published by permission of the Director of the National Physical Laboratory and the Director of Mechanical Engineering Research.

ATOMIC TIME STANDARDS COMPARED

British and American atomic standards of frequency, or "atomic" clocks, have been compared by work undertaken at the National Physical Laboratory.

Comparisons had already been made by means of radio transmissions, but two different methods gave different results and the average result indicated that the British clock was gaining relative to the American clock by seven parts in ten thousand million (less than a ten thousandth part of a second per day). This was a bigger difference than expected and was large enough to be troublesome in some radio applications. The International Union of Scientific Radio and the International Committee of Weights and Measures stressed the importance of a direct comparison freed from possible errors caused by the radio link.

Two "Atomichrons" made by the National Company Incorporated, Malden, Mass., were loaned for the purpose by the United States Army Signal Engineering Laboratory, and the National Company provided a third experimental model. All three have been compared at Teddington with the National Physical Laboratory Standard, American scientists from the Signal Corps and the National Company taking part.

The results show that the American standards are on the average gaining slightly on the British standard, but by less than four parts in ten thousand million, and the tests revealed the cause of a part of this discrepancy.

Continuing **Research and Development**

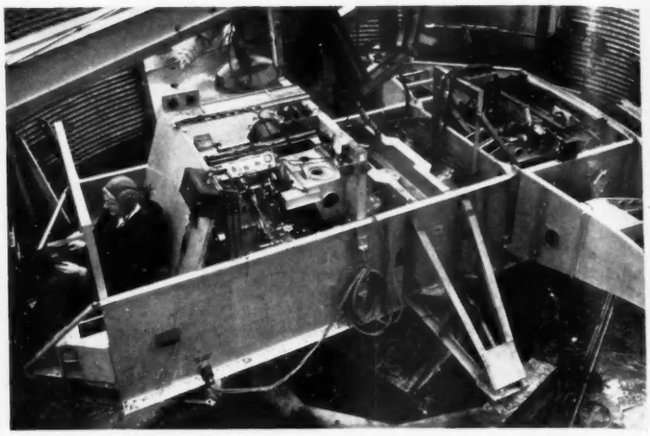
DYNAMIC RIG FOR VTOL DEVELOPMENT

A dynamic rig, serving as an advanced simulator for use in the development of the SC.1 VTOL research aircraft, has been designed and built by Short Brothers and Harland Limited, Belfast.

In the SC.1, it may be recalled, take-off and landing lift is provided by the vertical thrust from four Rolls-Royce turbojets. The rig will serve a dual purpose. Not only will it enable the company's pilots to become familiar with the control characteristics of the aircraft, but it will also be used for the functional testing of the hydraulic auto-stabiliser elevator power control and air nozzle systems of the SC.1—thus eliminating the need for a separate test rig for each system.

The dynamic simulator rig consists basically of a skeleton framework, representing the SC.1's fuselage and mainplane, in which the appropriate components are mounted, and the entire structure is supported by a specially-designed spherical air bearing which permits the rig to move freely on a "cushion" of compressed air, with virtually no friction. Hydraulic and electrical services, auto-stabiliser and transistor mechanisms, as well as all instrumentation necessary for pilot familiarisation, are duplicates of those used in the actual aircraft. Recording instruments for functional testing are installed in a separate room and connected to the rig by overhead cables. At a later date it will be possible to operate the rig remotely from this control room, either manually or by signals fed from a Short analogue computer.

Although no engines are mounted on the rig, ducting and air jet control systems are the same as in the SC.1, the necessary compressed air being supplied by either a modified Rolls-Royce Avon or Nene jet engine housed in an adjacent building. The air is ducted from the engine room, through a central hole in the spherical air bearing to a distributor head on the rig. To avoid adverse ground effects, however, the control nozzles in the wingtips, tail and nose—which, in the aircraft, provide lateral and longitudinal stability by their downward efflux—are inverted on the simulator to exhaust upwards; compensation being made by incorporating reversing links in the control circuits and correcting the auto-stabiliser accordingly. Aileron and elevator control surfaces are simulated by torsion bars and masses, representing respectively load and inertia. The rudder is not represented.



The programme being carried out on the dynamic rig will also include special "emergency" tests, in one of which the results of a failure in one of the aircraft's four vertical lift engines will be simulated. This will be achieved by moving a mass on the simulator to give an out-of-balance moment equal to the displacement of the vertical jet thrust centre, and at the same time shutting one of the ports in the air distributor head.

SIMPLER MICRO-WAVE AMPLIFICATION

Noise is a major problem in the amplification of weak micro-wave signals. Commercially available amplifiers and converters add a considerable amount of noise to the incoming signal, and so decrease the sensitivity of the receiving equipment. A large reduction in noise can significantly improve the performance of radio receivers such as are used in radar, radio astronomy, scatter propagation relays, and u.h.f. television systems.

A form of parmetric amplifier under development in Bell Telephone Laboratories holds promise of providing an appreciable noise reduction: variable reactance serves as the active component. In the present device, the variable reactance is provided by a semiconductor diode (varactor diode) whose capacitance varies with the applied voltage. As with similar amplifiers, the applied voltage is derived from a high-frequency pump signal, which causes the diode to function as a time-varying capacitance and furnishes the energy to produce amplification.

Amplification at 6 kMc/s was initially demonstrated at Bell Laboratories. Later a bandwidth of 8 Mc/s was obtained at the same frequency, with a noise figure of 5 to 6 dB; gain was 18 dB and the pump signal, 12 kMc/s. Gain can be traded for bandwidth if desired.

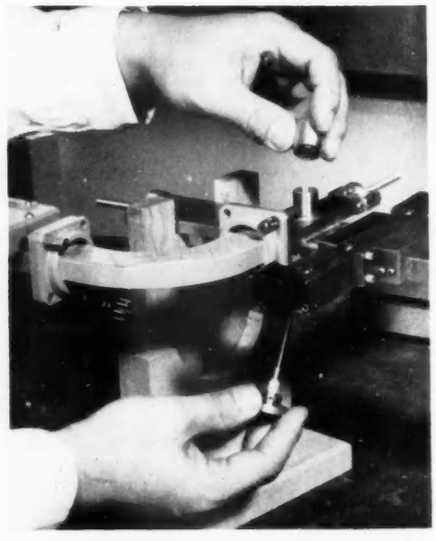
A travelling-wave amplifier configuration using arrays of several diodes shows promise of providing bandwidths of 25 per cent or more in the ultra high frequency region. With four diode stages, bandwidths of 100 Mc/s at 400 Mc/s signal frequency have been obtained. This requires a pump frequency of 900 Mc/s. A gain of 10 dB and a noise figure of 3·5 dB were achieved with a pump power of 10 mW.

Bell Laboratories claim that a single type of diode can be used to make an amplifier for any desired frequency—from the high micro-wave region down to direct current. The noise performance improves rapidly as the frequency decreases from micro-waves down to the u.h.f. region, thus making such an amplifier potentially useful for u.h.f. television receivers.

Interesting aspects of the diode amplifier are its simplicity and potential reliability. Major components are the waveguide structures, the diode itself, and a suitable pump signal source. It appears that these components can be assembled to provide a relatively inexpensive device. No magnetic fields are necessary and no refrigeration is required. The low noise characteristics are realisable at room temperatures.

Although the variable capacity effect is present in commercial diodes, Bell Laboratories have developed, under a United States Signal Corps contract, diffused silicon diodes to enhance the effect. Series resistance, which could be a source of noise is minimised in these diodes. Units have an effective diameter of about 0·002 inch.

(Left) A travelling wave amplifier employing four variable capacitance diodes has achieved a bandwidth of 100 Mc/s at 400 Mc/s.



(Right) The diode with the properties of a non-linear capacitor is shown in the right hand prior to insertion into a waveguide.

COMPUTING TRAIN TIMETABLES

When the performance of a train is specified, and details of the line it runs on are known, straightforward calculation yields the timetable that can be expected. To speed such calculations, British Transport Commission have installed an analogue computer in the office of the chief electrical engineer, British Railways Central Staff. Its main task will be to compute running times of new forms of traction introduced in the railway modernisation programme. New timetables, for both passenger and goods trains, will be drawn up from advance information obtained.

The computer was developed and built under the direction of Professor E. Bradshaw of Manchester University, in association with the chief electrical engineer. Alternating voltages are used to represent the various quantities that enter into the calculations. To solve the two basic equations—integration of acceleration with time to obtain velocity, and integration of velocity with time to obtain distance—modified watt-hour meters, similar to those indicating domestic electricity consumption, are used. A stabilised voltage is fed to the voltage coil of each instrument and a voltage representing the integrand is fed to the current coils.

Two methods are used to feed data into the machine. Gradients are entered on punched tape and other variables are drawn out as graphs. The operator with a train performance problem draws out the tractive-effort/speed characteristic of the train and selects a suitable train-resistance/speed curve. Such speed-dependent variables are carried on a vertical drum. The positions of stations and speed restrictions are marked on a horizontal 24 in chart with a distance base. Braking curves are drawn backwards from each point where a reduction in speed or a stop is made. The result of the computation appears as a continuous record of speed against distance, with an independent time trace displayed alongside. An indication of traction motor temperature can also be obtained.

The voltage applied to the current coil of the first integrating meter is derived from three sources and represents nett tractive effort. The three sources are: a Variac auto transformer driven by a mechanism following the tractive-effort/speed curve, or alternatively an auto transformer adjusted to the appropriate braking rate; a Variac auto transformer driven by the curve following mechanism for the train-resistance/speed curve; and a transformer having a secondary winding with tappings that provide turns ratios in powers of 2 up to 64 (2^6). The last feeds in information on gradients, which is punched on tape in binary code form. The tape is "read" by knife-edged roller contacts which operate relays to select the appropriate tappings on the secondary of the transformer. The seven sections of the winding provide 127 different combinations. Auxiliary relays control the sign of the gradient voltage.

The angular velocity of the disc of the first integrating meter is a function of train acceleration; its displacement is a function of train speed. To pick out the latter, the edge of the disc is painted with alternate black and white segments and light from a lamp built into the meter is reflected from them on to a photo cell. Signals from the photo cell pass through a phase discriminator, by way of shaping and differentiating circuits, to uniselectors that drive the drum carrying curves of speed-dependent functions. A drive from this operates the pen that records speed on the 23 in chart; a further drive imparts an angular rotation to a Variac transformer. The output from the last mentioned transformer represents speed and is fed to the second integrating meter. The rotation of the motor disc in this meter (a function of train distance) operates a second servo mechanism, similar to the first, that drives forward the 23 in distance chart and the punched tape. A synchronous motor provides a saw tooth time-base by means of a cam-following mechanism and a pen.

Provision is made on the vertical chart drum for a third-speed dependent function, for example, motor current in an electric train. A mechanism following this curve drives a Variac auto transformer that feeds an unmodified watt-hour meter, thus providing integration of current with respect to time. The result is recorded on the usual counter with decimal scales.

The product of current consumption and line voltage provides a continuous record of energy consumption, which is of value to the railway operator. Of more value to the designer is the time integral of the square of the current, which indicates the temperature of the traction motor and permits the behaviour of the motor on one duty cycle to be related to the machine's rating. This feature is provided in the computer by ganging a second variac transformer mechanically to the one used to indicate the current consumption and by arranging their electrical connections so that the output of the first forms the input to the second. A fourth watt-hour meter integrates the square of the current with respect to time and displays the result on another counter.

The automatic curve-following device operating on the speed dependent curves contains two probes 2 mm apart. These straddle the curve, which has a broad band of colloidal graphite along its lower edge, connected to earth. A feedback system causes a direct current motor to maintain the follower in such a position that one probe is in the graphite and the other out of it.

Speed-dependent variables relating to a specific train are read off the vertical drum by curve followers. The variation of train speed with distance appears on the horizontal chart.

MASER FOR PULSE WORK

In the course of the recent Convention on Microwave Valves, held by the Institution of Electrical Engineers, a number of papers were read on solid-state devices operating on the "maser" principle. Many were three-level devices but experiments made in 1956 showed that it should be possible to operate a two-level maser at a temperature of 1·2° K, using phosphorous impurities in a single crystal of silicon. Magnetisation reversal by means of an adiabatic fast passage, followed by a return of the magnetic field to resonance in a time shorter than the spin-lattice relaxation time, should be expected to produce amplification or spontaneous oscillation, depending on the magnitude of the external coupling of the resonant cavity to the waveguide. Experiments at the Bell Telephone Laboratories, described in a paper "A Two-Level Solid-State Maser," by J. P. Gordon, demonstrated that this was possible. At 9 kMc/s and about 3 kilogauss, spontaneous oscillations of about 20 microsec duration were observed. In this case the silicon crystal was of isotopically purified silicon 128, which exhibited an extremely narrow resonance (line width 0·27 gauss). The spin-lattice relaxation time of the sample was about one minute. Further experiments with a sample of unpurified silicon (line width about 3 gauss) showed that spontaneous oscillation could easily be obtained at 24 kMc/s. In this case there were about 3×10^{16} phosphorous atoms per cu. cm, and the sample volume was about 0·2 cu. cm. The operating temperature was about 1·3° K. The author discussed some of the theoretical aspects of the work and suggested that possible uses for this type of maser were as a pulsed amplifier or as a generator of microwave power.

STABILISING KLYSTRONS

Elliott Brothers (London) Limited recently demonstrated a method of stabilisation of klystrons that they are developing. The equipment operates in the X-band (about 9 kMc/s). A tunable frequency discriminator gives a signal proportional to the deviation of the oscillator from the nominal frequency; this signal is amplified and applied to the reflector electrode so as to tune the klystron electronically back to nominal frequency. For amplitude stabilisation, the current delivered by a crystal monitor is compared with a reference level and the departure from equality suitably applied to the coils of a ferrite electronic attenuator to reduce the departure from constant amplitude. The source can be used as a signal generator to supply a precision test bench or high grade measuring equipment.

MORE STAFF FOR SATELLITES

Artificial earth satellites have added to the research programme of the Radio Research Station of the Department of Scientific and Industrial Research. They introduce a new technique for the study of radio waves and the physical conditions of the upper atmosphere. To conduct the new project, additional staff are being recruited for the station's headquarters at Slough and its sub-station in Singapore. The station will carry out a programme of work in this field and act as an international centre to collect the results of observations made by other scientists. The DSIR point out that while the work involving rockets and satellites was started as part of the programme of the I.G.Y.—the initial arrangements being co-ordinated in Britain by committees of the Royal Society—it is expected that it will develop considerably.

EXTENDING STEAM TABLES

A project receiving a new grant from United Engineering Trustees, Incorporated, 29 West Thirty-Ninth Street, New York 18, N.Y., is a study of the properties of steam. The programme is under the sponsorship of the American Society of Mechanical Engineers and was established in 1954. It has the ultimate aim of extending the present working steam table range to 1,500° F and 15,000 lb per sq. in.

Production

RESEARCH FOR PRODUCTION ENGINEERS

PERA's Progress

Many of the research associations which were formed soon after the last war as a result of co-operative effort between government and industry, are now showing signs of outgrowing the difficulties of their early years when they relied very much on the support of their sponsors. New buildings, an expanding programme of research and development, and new services to members are sure signs of maturity and in this respect the Production Engineering Research Association, Melton Mowbray, Leicester—familiarly known as PERA—is no exception.

ECONOMICAL RETURNS

This is, perhaps, as it should be, for in no other case can the work of a research association, in terms of increased production efficiency to the industries it serves, be more readily ascertained. The following examples will serve to indicate some of the economical benefits to British industry resulting from PERA research and technical services: a reduction of 160,000 per year in the number of shells scrapped by a firm during deep drawing operations; a firm's output of mining equipment increased by 300 per cent by improved tooling and layout using only half the previous floor space. Another firm saved £40,000 by substituting an automatic high-speed process for a slow hand-finishing process; industrial application of the results of metal forming research have yielded savings of up to £30,000 per year in production costs in the case of a firm which is now cold-extruding electrical components instead of machining them. In some factories more than £1,000 per year has been saved by applying results of cutting fluid investigations. Improved methods developed for grinding tools have reduced the weekly turnover of carbide lathe tools by about 40 per cent, and breakage of standard tools was reduced by 75 per cent. A reduction in counting and packing time for small components has accounted for an annual saving of £1,600.

More difficult to assess, yet nevertheless of tangible value to member firms, is the technical enquiry service which provides assistance with members' enquiries, numbering as many as 3,000 per year, on all types of production problems; and the education and training centre which arranges intensive training and refresher courses for key personnel at all levels in industry. A mobile unit equipped with cinema and demonstration bay, and visits by members of the staff, are additional ways of keeping member firms fully informed of results of practical interest. At present there are 640 member firms, and the Association has a staff of 240, with a total income of about £250,000. Subscriptions are based on a member's annual turnover and range from 60 to 425 guineas per year.

RESEARCH BLOCK INAUGURATED

On 3 June, 1958, Lord Chandos officially inaugurated a new research block incorporating main workshops and metallurgy, radioactive, electronics, metrology and machine tool laboratories. The building cost £250,000 and has equipment worth £500,000. In its design the consulting engineers, Husband and Company, Sheffield, took special precautions to reduce the effects of vibration from installed machinery. Altogether the new building provides 45,000 sq. ft of floor space of which an area of 20,000 sq. ft is for the workshops.

The temporary auxiliary buildings which formerly housed the research laboratories have been converted into a training centre with lecture theatres, study rooms and demonstration bays where educational courses are held for foremen, superintendents, methods engineers and other personnel of member firms.

Following the inauguration ceremony, the work of the Association was open to inspection. A glance at the list of member firms producing such widely divergent products as glassware and gasworks plant, machinery and metal windows, toys and turbines, pneumatic equipment and nuclear reactors, to mention a few, clearly indicates the wide range of production activities to be embraced. Incidentally, this vast field probably accounts for certain criticisms of PERA's work which implied that it did not cover the whole field of production engineering, but was only concerned with certain aspects. Quite naturally the research programme at first had to be selective within the limited resources available, but as the income has grown it has been possible to extend the number of basic groups into which manufacturing techniques of common interest to all member firms, and indeed most production engineering activities, fall, such as metal forming, metal cutting, surface finish, machine tools, automation, etc.

TOOL SHAPE FOR EFFICIENT CUTTING

Carefully controlled investigations made by PERA have shown how the efficiency of simple routine machining operations such as drilling, reaming and tapping may be improved. For example, the shape of a drill point was found to have an important effect on drill life (Fig. 1); for steel En 10 a point angle of 95° and relief angle of 12°, gave the greatest drill life, the corresponding angles for steel En 3A being 110° and 12°, and for steel En 30B, 130° and 10°. These point angles are much greater than that of approximately 65° previously obtained for

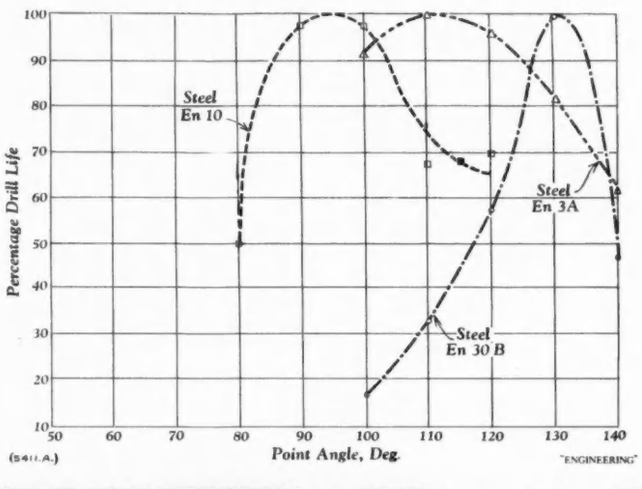


Fig. 1 (left) Effect of point angle on drill life when drilling various materials.

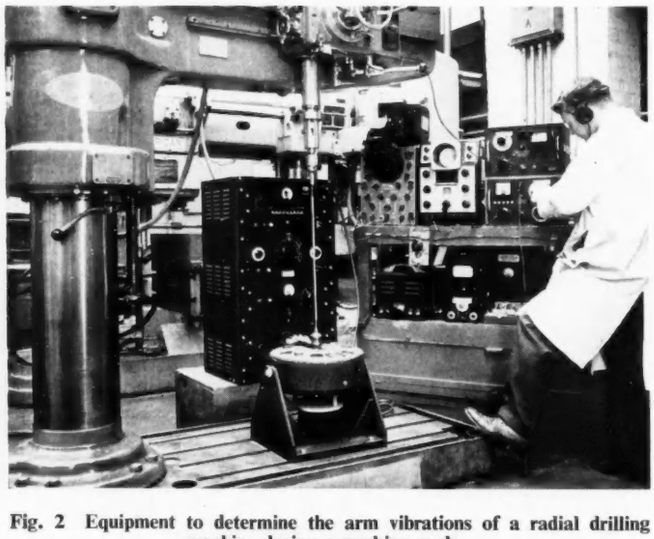


Fig. 2 Equipment to determine the arm vibrations of a radial drilling machine during a working cycle.

Fig. 3 A variety of components produced by cold extrusion from slugs, indicating the range possible.

cast iron. Other investigations have shown that grinding inaccuracies leading to errors in drill point symmetry may appreciably affect tool life; in the case of $\frac{5}{8}$ in diameter drills a reduction in relative lip height from 0·015 in to 0·001 in increased drill life almost three times. Dimensional accuracy of the drilled hole was also found to be very dependent on the symmetry of the drill point.

Research into grinding has indicated that substantial economies can be made in the grinding of tools, in the form of reduced grinding wheel costs and longer life between regrinds, by adopting controlled tool grinding techniques. For example, it was found that the method of grinding carbide turning tools had no marked difference on tool performance, but the approximate grinding costs per tool when using the metal-bonded diamond wheel, electro-spark erosion, or silicon carbide wheel method were 7, 8 and 11 pence respectively.

Provision has been made in the new laboratories for experiments using radioactive materials. For example, radioactive cutting tools (i.e., tools that have been irradiated in the Atomic Energy Research Establishment's experimental reactor at Harwell) will be used in a special lathe to determine tool wear. The amount of wear will be determined by measuring the radioactivity of tool fragments deposited on chips cut from the workpiece material. Pickup on the machined surface of the workpiece may also provide useful information about the cutting action itself. This technique, it may be recalled, was pioneered by Alexander Duckham and Company Limited (ENGRG., vol 182, 1956, p. 56).

In large machine shops the annual cost of cutting fluids is an important item in estimating machining costs. An interesting result of PERA researches into various aspects of the use of cutting fluids such as composition type, corrosive effects, method of application on machine cutting performance is that for moderate or high machining speeds, it may be that heat transfer, as distinct from lubrication, is the important property required. This was confirmed by turning, drilling and grinding tests comparing a conventional soluble oil emulsion with two oil-less water-based fluids (mains water treated to prevent corrosion of the tools and workpiece), when similar minimum tool lives were obtained with the three cutting fluids.

As a result of tensile and torsional tests on threaded assemblies, some useful design data have been obtained. For these tests the percentage depth of thread and thicknesses of tapped specimens were varied. It was noted that when the depth or length of the tapped specimen was equal to the nominal thread diameter or tap major diameter, most failures occurred in the bolt rather than by thread stripping. It was subsequently concluded from tests on cast iron and aluminium alloy nuts that the strength of threaded assemblies was not increased by having a depth of thread greater than 75 per cent in cast iron, and 60 per cent in aluminium alloy, and it was possible to recommend that for up to $\frac{1}{2}$ in major diameter sizes, the depth or length of a tapped hole in steel should be equal to the thread major diameter; in aluminium or cast iron the depth should be $1\frac{1}{2}$ diameters. These recommendations probably apply also to larger sizes where similar ratios of minor/major diameters occur.

MACHINE TOOL VIBRATION

An important part of PERA's research effort is devoted to improving the performance of machine tools. Comprehensive investigations have already been made with lathes, drilling machines, milling machines and grinding machines and some of the information obtained has been incorporated in specially constructed machines used by the Association, such as the rigid portal-frame machine for research into drilling, which was designed to eliminate machine deflection and vibrations effects.

A practical outcome of investigations into machine tool vibration characteristics has been the development of various types of vibration absorbers which when fitted to machine tools enable excellent surface finishes to be obtained under machining conditions which would otherwise have resulted in severe chatter, rough surfaces and in extreme cases, tool breakage. Another advantage of smooth, vibration free operation is that it is often possible to complete the work without additional machine finishing operations such as reaming and grinding. A set up for determining the arm vibrations of a radial drilling machine is shown in Fig. 2. Actual vibration records taken of the tool arm during spot facing are reproduced in Fig. 4 and clearly indicate the beneficial effect of an absorber. Bearings, such as the single-row angular contact ball bearings of the type used in lathe headstocks or internal grinding spindles, have also been investigated since geometrical inaccuracies, causing noise and vibration, affect the surface finish and roundness of turned workpieces. The increasing use of electronic equipment in production engineering research is provided for in the new research building by the electronics laboratory. An electronic chronometer, automatic pulse counter and tool travel computer were exhibited.

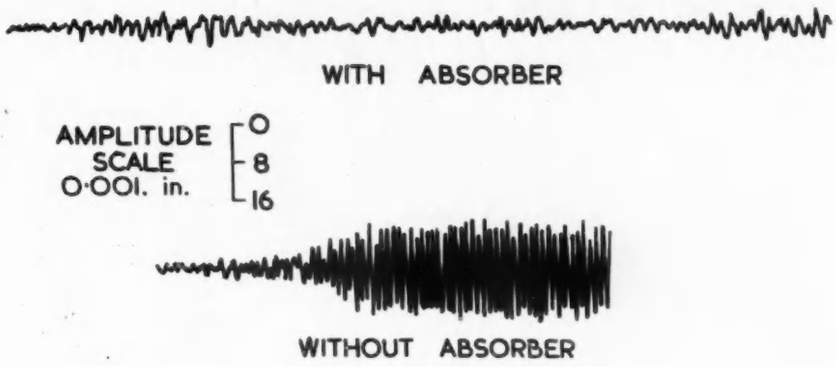


Fig. 4 Typical tool arm vibration records showing the usefulness of an absorber.

COLD EXTRUSION

The potential value of the cold extrusion process which can be applied to relatively high-strength materials such as steel, copper and aluminium alloy has not been so fully appreciated in this country as in the United States and on the Continent. A 1,000 ton Clearing extrusion press has been installed in the new workshops and the variety of intricate shapes which may be produced with relatively simple tools from a cold slug of metal in a single stroke of the press, is shown in Fig. 3. Production costs for some components can be considerably reduced by the reduction in production time and material costs made possible with this process. Many components at present machined to shape could be produced by this method since close dimensional tolerance can be maintained. Although large forces are required, one cold extrusion operation may replace several deep-drawing operations with inter-stage anneals. Another advantage is that the strength properties of low and medium carbon steels after cold extrusion are often similar to those of heat-treated carbon and low-alloy steels. PERA have investigated the variation of extrusion force with punch penetration when cold-extruding copper and steel, and relationships between the peak extrusion load and percentage reduction in area when extruding aluminium, copper and steel slugs as shown in Fig. 5. Other factors under investigation in the case of steel slugs are the effects on extrusion of the physical condition of the material, method of slug production and surface phosphate coatings.

Another interesting result of metal forming research was the influence of a small polished radius at the mouth of dies used for finish blanking of material thicker than $\frac{1}{8}$ in. Provided that there is a very small clearance between punch and die, it was found possible to achieve a good quality sheared-edge finish with aluminium, copper and steel without shaving operations. The thread rolling characteristics of a number of materials, including various steels, Nimonic 80, brass and aluminium alloy, have been investigated and a method developed for calculating diameter of blank from the geometry of the basic thread form.

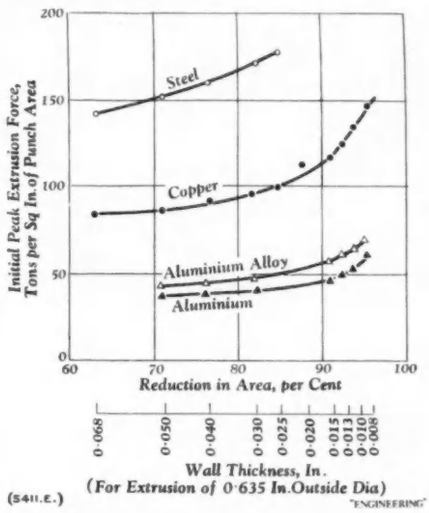


Fig. 5 Relationship between extrusion force and percentage reduction in area for various materials.

AUTOMATION

In 1955, a technical committee was set up to consider aspects of research which would be likely to help industry in the further development and application of automatic machine control and other features of mechanisation which could be described as coming within the general scope of automation. Since then the Association has been investigating a wide range of equipment of this kind to assist members in selecting and applying such devices. Several member firms have seconded engineers to PERA for periods of several months to obtain direct experience of the problems involved in automation and to expedite the Association's investigations.

A report was recently issued to members on hoppers and selector devices for machine tools and presses. Other reports will cover work loading and unloading equipment, such as magazines, mechanical hands, iron hands, etc.; work clamping equipment, work conveying equipment; the application of various types of automation equipment in machining and pressworking in small and large quantity production; and transfer machine tools and presses.

Lord Chandos, when opening the new research block emphasised the growing competition which British industry was having to face from overseas, and the need to meet this challenge by improving production techniques.

Continuing **Production**

TRANSPORT AND COMMUNICATIONS IN MINING

The application of efficient transport and communications in mining, with particular stress laid on the safety aspect, was discussed at the summer meeting of the Institution of Mining Engineers, held at Birmingham on July 2.

In his paper " Safety Aspects of Underground Transport in Coal Mines," Mr. A. E. Crook, C.B.E., H.M. Principal Inspector of Mechanical Engineering, Ministry of Power, summarised the changes which have taken place in underground transport practice since 1947, changes which were far greater than in the period 1920–1947, when rubber-covered conveyor belts were developed. The emphasis has been on mechanical handling between the coal face and the winding shafts, and fewer units, automatically operated and of greater capacity, have become the rule. Underground conveyors have increased in number until, by 1957, about 92 per cent of all deep-mined coal was conveyed during part of its journey from face to shaft. Rope haulage, though its use is diminishing, is still the principal means of underground transport, and is likely to remain so for many years. Locomotives have increased in number at a very great rate (from 64 in 1947 to 910 in 1957) and the number of mine cars has risen in the same period from a few to about 30,000. Concomitantly, the number of ponies employed underground has fallen to 11,092, just over half the figure of 10 years earlier.

These changes in the underground transport pattern have had their effect on the accident problem. The greater the number of automatic devices used, the smaller the number of workers employed, and this, coupled with proper design of the equipment from the safety point of view, should result in a lower accident rate. Nevertheless, there are certain possible hazards accompanying the use of any kind of machinery.

Conveyors, since the introduction of fire-resistant and anti-static belting, are much less likely to cause fires, but there is still a fire risk from moving parts which might generate heat, and the sudden dispersal of dust which accumulates on belts, conveyor structures and roadways can be dangerous. Many safety devices have been developed to deal with abnormal conditions which might arise, and these devices are useful so long as they are not considered as substitutes for a good standard of engineering practice in design, construction, operation, supervision and maintenance. Belt conveyors do not require many attendants, but there is an urgent need for a solution of the problem of contact with moving parts, which, by reason of their function, cannot always be securely fenced. Rope haulage systems and man-riding layouts, whether rope or locomotive hauled, are obvious possible sources of injury, and there are statutory regulations governing the design and operation of such installations.

Good design, installation, operation and maintenance can do much to reduce accidents but, as was stressed in the discussion following the paper, they are not the complete answer. In spite of the way in which these matters have been improved in recent years, accident statistics have not shown a corresponding reduction in injuries to personnel, and attention was drawn to the fact that there is still one contributory factor which cannot be measured or legislated against by any straightforward regulations—the personal element. There are some accidents for which there is no apparent reason. Much work remains to be done in assessing the contribution to accidents made by purely human factors, and in finding the root cause so that it can be eradicated.

Messrs. E. J. Kimmins and B. L. Metcalf, of the National Coal Board Headquarters pointed out in their paper entitled " Colliery Communication Systems " that no factory or commercial concern could function efficiently without adequate communications, and that the same is true of a colliery; unfortunately it is usually easier to modernise communications in a factory than in a mine. The basis of good communications was a well-planned telephone system and telephones should be installed according to a plan based on an ideal layout—all too often a system has grown up by the addition of instruments here and there as the need arose. The choice of systems available today is considerable, and it is possible to meet the requirements of any pit, large or small. Each system must be designed to suit particular local requirements, but there are certain overall considerations which can be laid down as general rules. Spare capacity should be allowed in the planned installation, and if the system is manually switched, a full-time operator should be employed, at least on the principal shift. At very small mines, and on quieter shifts in other mines, a full-time operator may not be justified, and in such cases the operator can also be employed on other duties, provided that, at all times, the switchboard takes precedence. At least two shaft cables should be installed, to reduce the risk of communication being cut off by a shaft accident, and some form of priority calling should be arranged, so that emergencies can be dealt with promptly.

RADIO AIDS

Telephones do not solve the problem, which arises from time to time, of communicating with moving vehicles. It may be necessary, for example, to communicate with men who are carrying out routine inspections in the shaft. For this purpose the traditional, and still current, means is the metal plate and hammer. When the question of communicating with locomotives or man-riding installations arises, however, neither telephones nor manual sound systems are practicable.

Radio, the obvious solution, is not easily applied, because radio equipment of normal pattern such as the " walkie-talkie " used on the surface, has such a limited range as to be virtually useless underground. In the United States, radio-frequency currents have been superimposed on the d.c. supply to trolley locomotives to carry speech, but in this country only one trolley locomotive installation exists in a coal mine, most of the locomotives used being either diesel or battery-operated. In Great Britain, therefore, the use of " guided " radio is being developed. This uses a conducting path, which can be many different kinds of metal object such as signal wires, the armouring of power cables or even water and compressed-air pipes. Signals are transferred into and out of the conductor by an inductive coupling between the conductor and an aerial attached to the set, and the set is free to move, providing that its aerial is never more than a few feet from the conductor path. Normal radio equipment is used on the surface for a variety of duties, including contact with road vehicles and with mines-rescue stations and their mobile equipment.

Not all the communications needed in mining are required to transmit speech. Code signals are generally easier to send than speech, and it is economical to use them where possible. Such signals can also be recorded automatically if required; an example is provided by a tub-counting device underground which operates a recorder in the surface office. To what extent this automatic transmission of information is practicable was shown by a demonstration accompanying the paper. A decelerometer on the cage at Sandwell Park Colliery, about five miles from the hotel in Birmingham where the meeting was held, was connected through a Post Office telephone line to a recording instrument in the meeting room. Two windings of the cage were recorded graphically, the graph being shown on a screen by means of an episcope as the record was made, and at the same time a commentary was given from the colliery-engine house by loudspeaker. As the authors of the paper said, the demonstration went beyond the needs of normal colliery operation, but it served to show very clearly that whatever information the colliery manager wanted transmitted, the communications engineer could do it for him where and when he wanted it.

TRADE PUBLICATIONS

Sintered Friction Material. THE MORGAN CRUCIBLE CO. LTD., Battersea Church Road, London, S.W.11. Morgan " Sinterlink " is a sintered friction material consisting mainly of bronze particles; it has been developed as a clutch facing for heavy duties. Advocated for crawler tractors, excavators, fork-lift trucks, cranes, lorries, shear and other presses, planing machines and other machine tools, coal cutter loaders, textile machines and other equipment. Folder SD.60.

Core-Sand Automatic Weighing Plant. THE SINEX ENGINEERING CO. LTD., Central Way, North Feltham Trading Estate, Feltham, Middlesex. Plant for the automatic proportioning, mixing and handling of foundry core sand at the Ford Motor Co.'s new foundry at Dagenham, by the Oerlikon punched-card system. Illustrated descriptive folder.

Plumbago and Refractories. THE MORGAN CRUCIBLE CO. LTD., Battersea Church Road, London, S.W.11. The history and development of the company is given in a leaflet entitled " Stepping out with Progress." Complete lists of the products of the company and of its subsidiary and associated companies are included.

Welding-Inspection Service. METAL AND PIPELINE ENDURANCE LTD., Artillery Mansions, Victoria Street, London, S.W.1. The firm offers a complete welding-inspection service coupled with non-destructive examinations by radiography, ultrasonic technique and other methods. The firm also undertakes to test welders. Explanatory brochure.

Data on Welding. EUTECTIC WELDING ALLOYS CO. LTD., North Feltham Trading Estate, Faggs Road, Feltham, Middlesex. Descriptions of simplified welding procedures for application to all metals at reduced temperatures. Pocket-sized data book of 180 pages.

Thread Milling. WICKMAN LTD., P.O. Box No. 44, Banner Lane, Tile Hill, Coventry. Wickman Moulton universal thread milling machine for internal or external threads up to 5 in diameter on workpieces up to 20 in between centres, or longer if special beds are supplied. Illustrated bulletin, punched for insertion in ring binder.

Oil-Type Rust Preventive CRODA LTD., Cowick Hall, Snaith, Goole, Yorkshire. Uses, composition and properties of a thin brown liquid, termed 90/40 and consisting of a blend of mineral lubricating oils, wool-grease derivatives and hydrocarbon solvents for the protection of steel surfaces when stored indoors. Information brochure.

Liquid Floor Coating. DOHM LTD., 167 Victoria Street, London, S.W.1. Liquid floor coating for concrete, wood, brick and bituminous surfaces—termed Can-Tile and advocated for the floors of garages, workshops, showrooms, offices, warehouses and factories. Available in tile red, battleship grey or white. Illustrated folder.

Methane Indicator. JOBERG LTD., 33 Barbican, London, E.C.1. The R-J methane indicator speedily determines, by optical means, the methane content in mine air. Can also be used for carbon dioxide, hydrogen, petrol vapour, acetylene, sulphur dioxide, sulphuretted hydrogen and other gases. Illustrated folder.

Electrical Detarrers. W. C. HOLMES & CO. LTD., Turnbridge, Huddersfield. Holmes-Elex electrical detarrers, for the removal of tar " fog " from coal gas, carburetted water gas, producer gas, coke-oven gas and oil gas. Explanatory folder.

Thick Aluminium-Alloy Plate. NORTHERN ALUMINIUM CO. LTD., Banbury, Oxfordshire. Thick high-strength stress-relieved aluminium-alloy plate now being made by the firm for the aircraft industry. Technical booklet guide to the material.

Book Reviews

CONCRETE OVERHEAD

Proceedings of the Second Symposium on Concrete Shell Roof Construction, 1-3 July, 1957. Edited by A. AAS-JAKOBSEN, SIGMUND BRUSLETTO, IVAR HOLAND and GUNNAR OXAAL. *Teknisk Ukeblad, Kronprinsensgt.* 17, *Oslo* 9, *Norway.* (107*s.*)

The first symposium on shell roofs took place in London in July, 1952, under the auspices of the Cement and Concrete Association, who published the proceedings. Whilst it was intended as a United Kingdom affair, it, nevertheless, attracted a large number of foreign engineers. An American conference on the same subject took place two years later at the Massachusetts Institute of Technology, but attendance was effectively restricted to engineers from the Americas. The third meeting, in Oslo last summer, may therefore rightly be regarded as the second international symposium.

The intention was to obtain contributions from the entire world and a glance at the list of authors will confirm the considerable success achieved. In particular one must note the contributions from Russian engineers and applied mathematicians, whose work has been known to date mainly by repute. It is pleasing to find that most of the contributions have been presented in English, the official language of the symposium, and regrettable that German authors chose always to ignore this, even in cases where they are known to be fluent in English.

The proceedings are collected under a number of subject headings, the first of which is entitled "Recent Notable Shell Structure Designs." Whilst the work in most countries has been obviously directed towards lower costs and larger structures along more or less conventional lines, in the Latin countries many new and interesting forms have been developed and used. This is perhaps due to less stringent enforcement of accepted criteria of structural safety. Most northern countries demand a mathematical demonstration of strength and stability which it is evident could not at present be produced in some of the cases exemplified. Torroja makes the point that the results of model tests (in which field he has considerable experience) should be equally as acceptable as a safety criterion.

The second subject is entitled "New Trends in Shell Design." Sixteen papers were contributed under this heading. The paper by the distinguished Russian Vlasov is imposing and likely to repay effort spent in its study. The paper by Jenkins is a useful and novel application of the principle of stationary complementary potential energy. It is worth mentioning that the method is applicable to cylindrical shells of varying thickness and radius and with none simply-supported ends. The papers by Tottenham and Csonka on doubly curved shells provide a number of new ideas. The reviewer would also draw attention to the paper on limit analysis by Olszak and Sawczuk, two of the Polish team which is doing so much in this field.

The subject "Shell Research" might well have described the previous group of papers so that few were left save reports of experimental work from Spain, Holland and Britain and a paper by Morice largely devoted to the application of electronic digital computers to shell analysis and design. It is evident from the proceedings that it is only in Britain that such work was in hand at that time. The final subject heading, "Prestressed and Precast Shells," contains two papers which provide little that is new.

The volume is an impressive one and will remain for long a source book on its subject. It reflects much credit on its group of editors, and in particular on Dr. Jakobsen, who was primarily responsible for the idea of the meeting and for selecting its contributors.

Reinforced Concrete in Architecture. By ALY AHMED RAAFAT. *Reinhold Publishing Corporation,* 430 *Park Avenue, New York* 22, *N.Y., U.S.A.* (15 dol); and *Chapman and Hall Limited,* 37 *Essex Street, London, W.C.*2. (120*s.*)

This volume is obviously intended for the consumption of architects and no doubt the format and typography will please them. The engineer will probably find it initially difficult and somewhat forbidding. However, if he is prepared to persevere he will get used to it, as did the reviewer, and find something of interest.

The book begins with a fairly authentic history of reinforced concrete and a less satisfactory section on materials. With these preliminaries over it settles down to its intended form of a picture book with commentary describing the growth of the use of reinforced concrete and a broad classification of its structural forms. There is a great wealth of illustration, a total of 370, mostly photographs which are, with a few exceptions, well chosen. A useful volume for the waiting room.

NEW BOOKS

Welding Aluminium Alloys. By J. H. GREEN. *The Association of Engineering and Shipbuilding Draughtsmen, Onslow Hall, Little Green, Richmond, Surrey.* (4*s.*)

Subtitled "An Introduction to the Inert-Gas Shielded Arc Processes," this 51 page manual for designers is based mainly on experience in the shipbuilding industry of the welding of light alloys. It covers the various processes, aluminium alloy compositions, strength consideration, design for welding, inspection and control, cost, quality, welding currents, automatic welding, special equipment, and future trends.

New Ways in Management Training. By CYRIL SOFER and GEOFFREY HUTTON. *Tavistock Publications Limited,* 2 *Beaumont Street, London, W.*1. (15*s.*)

The study reported in this book was carried out during 1954-1956 by the Tavistock Institute of Human Relations, in collaboration with the Department of Management and Production Engineering, Acton Technical College. The objectives of the study were to examine the function and possibilities of a department of management and production engineering in serving industry, to examine its services and structure, and to establish the most effective feed-back mechanism from industry to the department. The authors conclude that, while the technical colleges have unique opportunities for integrating academic instruction with practical industrial experience, they are unlikely to make effective use of them without radical changes, as a result of the conservative outlook inherent in a publicly financed organisation. Nevertheless, a determined teaching group backed up by enterprising authorities can make positive advances in the flexibility necessary to successful management training; and it is suggested that one or two departments might be chosen by the educational authorities on developmental units for continued research observation and experiment.

Engineering Precision Measurements. By A. W. JUDGE. *Third Edition Revised. Chapman and Hall Limited,* 37 *Essex Street, London, W.C.*2. (65*s.*)

The author gives a practical survey of methods, machines and instruments for making engineering measurements in the production shops. In this third edition there are four new chapters on slip gauges, straightness and flatness measurements, interferometry, and surface finish. The treatments of engineering fits, screw threads, gear testing, roundness testing, and projection methods have been amplified and brought up to date, and a brief account of automatic gauging and work sizing has been included.

On the Shelf

By Frank H. Smith

This column has now broken all records for raps over the knuckles. The latest is from the Institut International du Froid. On 16 May, I implied dilatoriness in publishing the *Proceedings of the Ninth International Congress of Refrigeration* (1955). Further, I quoted a price in dollars. The Secretary of the Institut International du Froid, Maclaren House, 131 Great Suffolk Street, London, S.E.1, writes to point out that the proceedings were available a year after the congress and were available in London for sterling.

When I saw "A Training Bibliography" in *Technology* for May (p. 94), I could not, at first, think what was unusual about it. Then I realised that, while there were such indications as Sept., July, Nov., and so on, nowhere was there a year. Another peculiar thing about it was that where one usually gets an author's name first, this list gave the publication (in alphabetical order) in which the reference appears. I assume that all the references are 1957, but the whole thing looks rather queer and I feel that some explanatory note should be given.

The du Pont Information Service (5133 du Pont Building, Wilmington, Delaware), feed me with information about a new "Cronaflex" engineering reproduction (*see* viviparous) film. This has all sorts of virtues and Mr. John A. Laberee at the given address will be happy to let you have the lot.

Remember that old First World War cry "Wake up England"? The Memoires of the Société des Ingénieurs Civils de France (a conservative lot if ever there was one) now have inserted index "boxes" giving the titles and abstracts of the contents in English, Spanish, and German as well as the native language. The size of these inserts is peculiar and it looks as though they are intended for pasting on index cards, but this cannot be as they are printed on both sides. Unless, of course, they appreciate that one will require only one language, in which case they *can* be cut out and pasted on to cards—except they are a funny size, which is back where we started.

The Special Libraries Association (31 East Tenth Street, New York 3) has a Translation Center (*sic.*) located at the John Crerar Library in Chicago. This center—sorry—centre can now furnish "on a subscription basis, printed catalog cards for current scientific and technical material which has been translated into English from all languages, including Russian." There is a lot more to the circular I am reading and I would suggest that translation-addicts apply to the New York address for a copy.

Collecting numbers? The Petroleum Information Bureau (29 New Bond Street, W.1, HYDe Park 6308) has recently produced *U.K. Petroleum Industry Statistics Relating to Consumption and Refinery Production* 1956 *and* 1957. This booklet gives some wonderful material for sherry party conversation. "Did you know that the production of petroleum products from imported and indigenous crude and process oils, including shale, was only 5,909,161 tons last year as against 6,771,195 the previous year. Motor and aviation spirit that is, of course.

The American Institute of the Aeronautical Sciences has been in existence only a short while compared with our own Royal Aeronautical Society (about 25 years as compared with 92) but what it lacks in years is more than compensated by energy and growth. It produces two regular magazines—the *Journal* and *Aeronautical Engineering Review.* The latter is now (from May) to be changed to *Aero/Space Engineering* and, as a title for a technical society publication, I think this is ghastly. If I could think of a stronger word I would use it. It is, of course, intended to reflect the changed interest of aeronautical engineers but the old title would have been quite adequate for that purpose.

Design

AUTOMATIC INTERCEPTION *P.1B's Fire Control System*

Some information on the radar and fire control system for the English Electric P.1B all-weather fighter aircraft has now been released by Ferranti Limited, Edinburgh. Known as Airpass (Airborne interception Radar and Pilot's Attack Sight System), the makers claim that it is one of the most versatile airborne radar systems in the world.

At the time of the Battle of Britain, ground radar was necessary to direct single-seat fighters so that they could make contact with the enemy. At the speeds and altitudes of to-day's aircraft, and with the longer-range weapons that are now available, unaided visual contact by pilots flying day fighters can no longer ensure a successful attack.

It was to meet this difficulty that Airpass was developed. The pilot using this system may never see his target and yet can still destroy it. The system forms a vital link in the chain of defence, enabling a fighter pilot to search for and find any hostile aircraft by day or night, manoeuvre into a suitable position for attack, aim his weapons and destroy the target.

Airpass comprises an advanced radar unit and a sighting system. The former gives information to the pilot in simple usable form, enabling him to intercept the target and lock the radar beam to it. Thereafter the radar accurately and automatically tracks the target. It feeds information to the sighting system where it is presented to the pilot in such a way that he can quickly and easily manoeuvre into a suitable position from which to attack with guns, rockets, or guided weapons. The sight ensures that the weapons are correctly aimed even though the target may be invisible to the pilot and travelling at supersonic speed.

In a typical interception, ground radar will set the pilot in the general direction of the approaching target. Airpass will then take over. The radar beam will scan a sector of sky covering a wide angle, horizontally and vertically, on either side of the flight path, and extending many miles ahead of the fighter. When the target is located the radar will lock-on and a computer in the radar unit will automatically work out the best approach course for the pilot to follow.

The pilot follows the correct approach and completes his attack using the information presented to him in his sight. If the target should come into the pilot's view he can take advantage of the normal visual sighting methods which are included in the system. An automatic warning device is incorporated to tell the pilot when to break off the attack if he should approach close enough to be in danger of colliding with the target.

Airpass is seen here installed in the nose of a Canberra flying test bed.

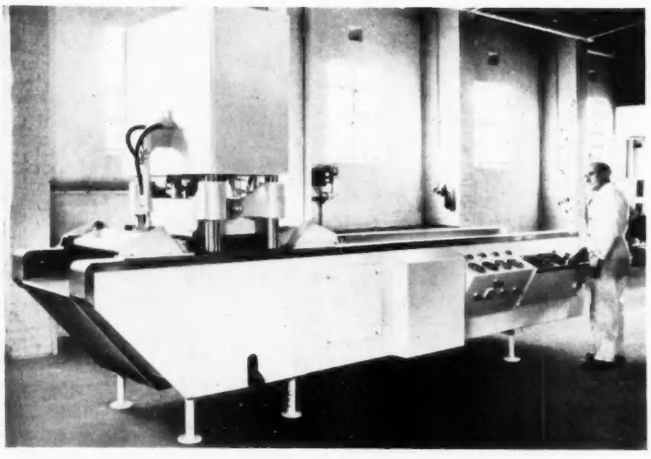
In Airpass the radar unit is housed in a single container or " bullet," which, in the case of the P.1B, forms a complete centre-body in the engine air-intake. In this way the P.1B carries a powerful radar equipment without increasing the frontal area unnecessarily, and at the same time preserves a good aerodynamic form. A considerable saving in weight is effected by the elimination of the usual number of boxes and interconnecting cables, particularly since the radar " bullet " actually forms part of the aircraft structure. The packaged design of Airpass is small enough to be installed even in lightweight fighters.

LIQUID-EXTRACTION PRESS WITH AUTOMATIC CONVEYOR

For extracting water, oil or juice from such materials as wood pulp, coal fines, sewage sludge, oil seeds or fruits—where either the dried solid or the liquid may be the required end product—an automatic conveyor press has been developed by Modern Mechanisation Limited, Elmswood House, 52 Bounds Green Road, London, N.11.

Advantages claimed for the press are: (1) there is no movement between the material and the pressing faces while pressure is applied. (2) The amount of pressure and the time during which it is applied, are adjustable and automatically controlled. (3) The material is pressed in comparatively thin layers, the liquid being expressed vertically, thus taking full advantage of gravity and simplifying its collection. In addition, the machine is easily cleaned by hosing down, and is readily accessible. It is a completely self-contained free standing unit requiring no complicated foundations, no ancillary equipment other than a supply of electricity and no operators in attendance.

The machine consists of a hydraulically-operated down-stroke platen-type press, the bed of which is trough-shaped. A conveyor belt passes through this trough, which is 8 in deep and which fits the platen closely. The belt, made from a filter-type textile material, is arranged to move intermittently under the press platen by means of a hydraulic ram. The open ends of the trough are closed by means of two hydraulically-operated gates. When the gates are closed, the bed of the press forms an open-topped box in which the platen fits like a movable square plug and on its down stroke will compress the contents. The conveyor belt in the bottom of the box is supported by a wedge wire grid which in turn rests on a heavy cast grid designed to take the full load of the press.



Conveyorised liquid-extraction press with adjustable and automatically-controlled platen pressure and time cycle.

When the platen descends into the box, liquid is forced out of the material through the belt and wedge wire grid into a collecting tray and then by way of a short pipe to a suitable receptacle or process pipelines. The press is preceded by a troughed feed section in which the conveyor belt runs, and material to be processed is levelled prior to entering the press.

The machine has a platen 24 in square, a stroke of 7 in and is covered with a rubber pad designed to even out the pressure over the whole area to accommodate irregularities in the density of the material. The platen pressure is approximately 300 lb. per sq. in but can be increased to 450 lb per sq. in. Any pressure up to this maximum can be automatically maintained for periods up to five minutes by means of an electric timer. A further range of machines has been developed for materials requiring much higher pressures.

The press is entirely automatic in operation and is controlled by electrically-operated hydraulic sequence valves. The cycle commences with the press at the top of its stroke. The belt ram moves the belt forward, carrying a new charge into the press. The ram has a torque-limiting device which prevents the belt from being damaged; the belt travel may also be adjusted.

When the belt stops, the gates close, thus cutting off a section of material, and the pressure block descends. The amount of pressure and the time during which it is exerted by the platen are under the control of the supervisor and may be pre-selected.

At the completion of the time cycle the gates open, the press rises, and the conveyor belt is moved forward once again. When automatic operation is selected, this cycle of events will repeat itself indefinitely without intervention.

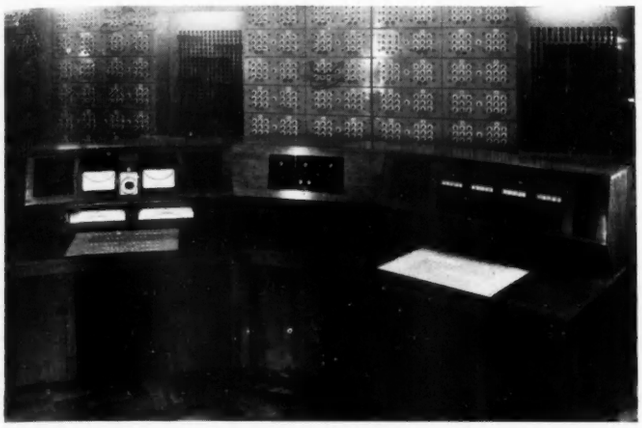
The machine is equipped with means for controlling the platen approach speed, to obviate splashing when dealing with very soft or pulpy materials, and for controlling the pressure build-up rate to facilitate maximum liquid extraction of certain materials. The output of the press depends upon the pressing time and the depth of the bed used, and can only be determined by experiment. Its maximum, however, when loaded to its full depth of 6 in would be 2 cu. ft of material per cycle. The makers' experience is that 4 cycles per minute are possible allowing a pressing time of approximately 10 sec, i.e., 480 cu. ft of raw material per hour.

OVERCOMING STRUCTURAL AND OPERATIONAL COMPLEXITY

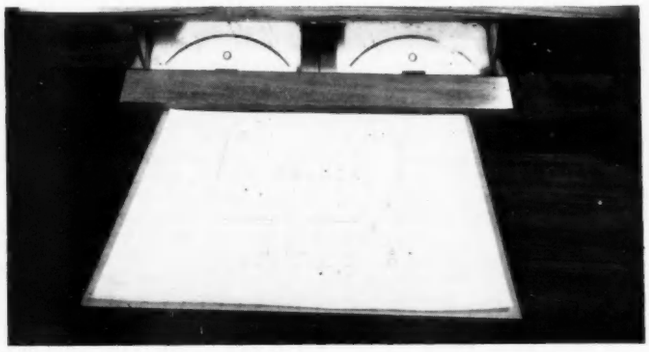
Full-Scale Network Analyser Using Transformer Analogues

Before spending heavily on a project, it is often wise to study a model to see if it predicts success for the full-scale equipment. Analogue computers greatly extend the scope of this procedure. Their use of simple electrical quantities to represent a wide range of physical variables gives a new freedom to the designer. Network analysers are a form of analogue system used in the study of power distribution networks. They are used in other fields of investigation too.

Network analysers reveal steady-state conditions. It is possible to discover the loads carried by each line of a network of transmission lines; to observe the effect of certain lines being out of operation, or of various alternators being out of service; to record the fault currents that flow when a short circuit occurs. The other investigations on which a network analyser can be used include general circuit analysis, design of rotating machinery, framework stress analysis, and heat flow analysis—to mention a few. Simultaneous polynomial equations can be solved, but not integro-differential equations.



The design of the control desk and plug boards enables operators to use the analyser in the same fashion as a conventional machine. No understanding of the underlying transformer analogue theory is required.

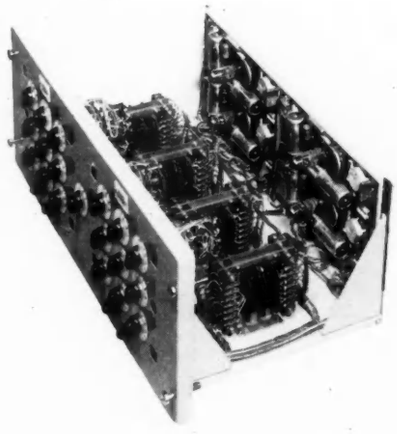


Plotting charts on the control desk allow entry of results into the appropriate sections of the network under investigation. As a unit is metered, its position is illuminated on the chart.

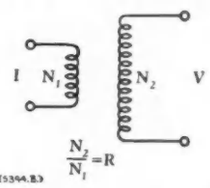
Such variety of application puts a particular form of constraint on the design of a practical analyser: it must be flexible, it must be easy to set up for an individual problem. In addition, the analyser must meet the requirement of any model—it must be accurate.

A form of analyser proposed by Mr. C. L. Blackburn in 1937, was not easy to set up. Also it was difficult to understand. For whereas a conventional analyser uses a network of impedances—resistors, capacitors, inductors—to simulate a problem, the Blackburn machine uses analogues of impedances: three-winding transformers simulate whatever impedance is required. The machine has a high inherent accuracy and it also has a much wider range of application than conventional analysers.

With increasing demands for the last-mentioned advantages, the transformer analogue machine began to be viewed as a practical possibility. In fact, the General Electric Company Limited decided that a machine using the principle would be the type most suitable for their own requirements, provided the complications in structure and operation could be overcome. For, in comparison with a normal machine, the transformer analogue equipment has 6 to 8 times as many leads, and the interconnection of individual units is complex, bearing little relation to that of ordinary networks. However, a full-scale analyser of this type has now been installed in the company's Witton works, Birmingham.



Units are mounted in pairs. The electronic circuit that compensates for the magnetising current uses printed circuits.



Simulation of a resistance by an ideal transformer.

When a voltage equivalent to the current through a resistor is fed into one winding, a voltage equal to the turns-ratio times the current appears across the secondary. By making the turns ratio equal to the resistance, the secondary voltage becomes equivalent to the potential across the resistor.

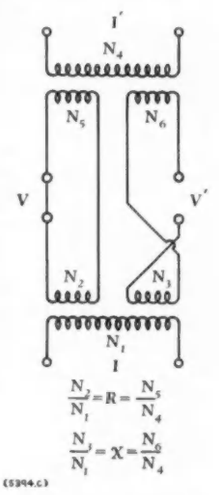
The Witton network analyser is built in four individual sections, each section containing 52 analyser units. Each unit consists of two transformers suitably cross connected, and is capable of simulating any type of positive or negative complex impedance, admittance, current or voltage injection quantity, or purely complex qualities in equations.

To overcome the connection complexities, the leads at each end of a unit are carried through a single multi-core cable to two plugs on flexible cords at a centralised plug-board. There are four plug-boards, each serving 52 units. The two ends of a unit are designated "red" and "green"—one plug is used for the red, the other for the green. Thus units are connected in series by plugging the red end of one unit into the green end of another, or in parallel by connecting the two red ends into one bus-bar and the two greens into another. In this way it is possible to build up a full system network, with the system bus-bars being copied on the plug board; that is, conventional network analyser practice is followed.

The ultimate accuracy of the analyser depends on the degree to which the actual transformers used approach the "ideal" transformers of theory. To do this it is necessary to reduce the apparent magnetising currents. Electronic circuits are built into each unit to continuously monitor the volts-per-turn on the transformers and inject the required magnetising ampere turns into a compensating winding. The result is that the currents flowing in the actual transformer network are reduced to a low value. Printed electronic circuits are used.

METERING

The metering arrangements enable operators to use the analyser directly, as a conventional machine. A knowledge of the underlying transformer analogue principle is not needed. The control desk is arranged in two halves, which contain the direct and bridge metering respectively. Control switches make it possible to couple any of the four plug boards to either metering system. Selection buttons allow any unit to be metered;



Simulation of a complex impedance by two ideal transformers.

Voltage equivalents to the components I and jI′ are fed into separate windings. If the impedance to be simulated has the value R + jX,

$$V = IR - I'X$$
$$V' = IX + I'R$$

When the turns-ratios are given the values indicated in the figure, the secondaries yield the required components of the complex voltage across the impedance.

In the Witton analyser the loads are represented by admittances rather than impedances.

Continuing **Design**

it is possible to select the voltage from either end of the unit to neutral, or the voltage across the unit.

" Direct " metering transforms the analogue voltages picked up from the analyser into the normal quantities of the system being analysed: volts, amps, watts, and vars. Electronic computing stages carry out the procedure and feed four high quality meters scaled directly in " per unit " quantities. A wide range of scales is available.

" Bridge " metering equipment measures the two Cartesian co-ordinates of the voltage and current at a required point. Illuminated in-line numbers display the results. The equipment consists of four independent self-balancing bridge units, which consist basically of automatically tapped reference transformers. An electronic detector measures the unbalance voltage between the input being metered and the output of the reference transformer and adjusts the tapping on the latter. The average time for a balance is about 2 sec and the equipment gives an accuracy of 0·1 per cent.

Each half of the control desk has an illuminated plotting table divided into 305 squares. When a unit is selected for metering, its square on the plotting table is illuminated. Results are entered on record sheets fitted over the table by recording in the illuminated position the reading for the corresponding unit.

CAPABILITIES

The arrangement of four similar units enables four separate studies to be run in parallel. The plug-boards can, however, be interconnected so that a large problem can be continued from one board to another.

With all four sections in operation, the analyser can be used for any size of steady state RLC circuit calculation, up to a maximum of 208 complex impedance units (i.e. $\pm$ R $\pm$ j X). In mathematical work, any expected order of polynomial with real or complex roots can be accommodated. Solutions of 14 $\times$ 14 complex, or 20 $\times$ 20 non-complex, matrices are possible. Matrix inversion is quickly obtained.

THE WESTMINSTER FLIES

The Westminster " flying crane " helicopter has made its first flight, lasting 1 hour 4 min, only 12 days after it was wheeled out of the final assembly hangar at the Yeovil works of its makers, Westland Aircraft Limited. It had been expected that a rather longer period would be required for pre-flight ground tests.

The Westminster, at nearly 14 tons, is the biggest helicopter project ever undertaken as a private venture by a British aircraft constructor. D. Napier and Son Limited, Acton, London, W.3, have shared in this private enterprise by developing the two rear-drive Eland gas-turbine engines which drive the five-bladed rotor.

First flight of Britain's " flying crane " helicopter, which took place only 12 days after assembly was completed.

FREIGHT RATES AND TANKER DESIGN

It has for long been held that within certain limits large tankers are more economic to run on long voyages than smaller ones. In an interesting article called " The Trend to Supertankers " in the first edition of 100 *Al*, a new bulletin put out by Lloyd's Register of Shipping, the argument is put forward that there is an optimum relationship between the shape of supertakers and the level of freight rates.

The argument makes use of the idea of the " block coefficient " of a tanker which can be approximately defined without a diagram as the amount of a square prism filled by a tanker, the length, height and breadth of the prism being equal to the corresponding maximum measurements of the tanker. The more of the square prism which is filled by the tanker, the higher the block coefficient. This block coefficient can be related to the delivery in tons of oil per year by a tanker, and when this is done it is found that the tonnage delivered increases with the block coefficient up to a certain optimum value of the latter and then falls as the block coefficient is raised further. It was found (and this was particularly relevant for the Suez Crisis) that in the case of a 900 ft tanker voyaging from the Persian Gulf to the United Kingdom via the Cape, and assuming bunker fuel at £7 a ton, the optimum block coefficient for given speeds fell significantly as freight rates increased.

From the general point of view the interesting question which these facts raise is as follows. The optimum block coefficient is different for varying levels of freight rates. It therefore follows that if one assumes a high level of freight rates the optimum block coefficient is different from the one which operates if one assumes low freight rates. This is another way of saying that the design of tankers should be responsive to assumptions about the long-term level of freight rates. If freight rates are high, block coefficients should be relatively low. This means that tankers should be slightly more streamlined and should correspond more closely to the shape of passenger liners than would be the case if freight rates are low.

ACCOMMODATING TANKERS

The Mersey Docks and Harbour Board is to develop a project for berthing supertankers in co-operation with the Shell Refining Company on the south bank of the Mersey. This scheme at Tranmere involves the construction of two large floating stages near Cammell Laird's ship building yards, each capable of taking a fully loaded supertanker of up to 65,000 tons deadweight. Even larger vessels may be accommodated on a restricted draft.

Each of these floating stages will be 362 ft long and 60 ft wide with a timber deck supported on steelwork. To ensure secure berthing, floating mooring dolphins will be provided, ahead and astern of each stage. These incorporate special features on which patent applications are pending. They have been designed by engineers of the Shell Refining Company, and the final form is the result of collaboration with the Mersey Docks and Harbour Board. They will achieve considerable saving in construction costs compared with one long continuous stage. The whole scheme has been worked out to allow for the large tidal rise and fall of the Mersey, which is over 30 ft.

Access to the stages will be by a forked approach jetty carrying the roadway, pipelines and other services. The oil stage will be the property of the Board and the oil lines will be owned by Shell. The oil will be pumped by ship pumps through pipelines into storage tanks on the reclaimed land nearby. It will then proceed by shore pumps to Stanlow.

The Mersey will thus be equipped to deal with all but the very largest supertankers planned at the present time. At first sight, this might appear to be something of a limitation, but bearing in mind that the project has been designed specifically to feed one of the largest petroleum refining centres in Europe with crude oil from the Middle East, transported in a fleet of 60 ocean-going tankers operating on a shuttle service, there should be ample opportunity for the ships to be operated on an economic basis and written off over a reasonable period of years.

The problem of accommodating tankers at existing installations does not of course stop at unloading facilities. For some time the development of deep-water terminals has been engaging the attention of the tanker industry and now Vickers Limited announce that a new large dry dock is to be built by Vickers-Armstrongs (Shipbuilders) Limited on the Tyne. The new dock will accommodate tankers up to 80,000 tons deadweight and will be largest on the east side of Britain.

HYDRAULIC ENGINEERING COURSE AT DELFT

An opportunity for graduate engineers to profit from the wealth of Dutch experience in hydraulic engineering is offered in the form of an 11 months' international course at the Technological University of Delft. All instruction is in English, and the course, which begins on 22 October, includes lectures, excursions, design and practical work. Engineers wishing to enrol for the course should have a thorough knowledge of the fundamental principles of construction, applied mechanics and hydraulics, and a good knowledge of calculus. Three programmes of study are offered:—(*a*) tidal and coastal engineering works, including harbours; (*b*) reclamation operations; and (*c*) rivers and navigation works, including groundwater recovery.

The academic year is divided into two terms during which classes are held, followed by a period of practical work and a final term. The first term is spent mainly in lectures and discussions, and simple projects are worked out in small groups. In the second term, the emphasis is on larger projects which are considered in small groups under active guidance. During the first two terms, visits are organised to hydraulic research institutions and large hydraulic undertakings. The facilities of the university's hydraulics and soil-mechanics laboratories are available to students throughout the course.

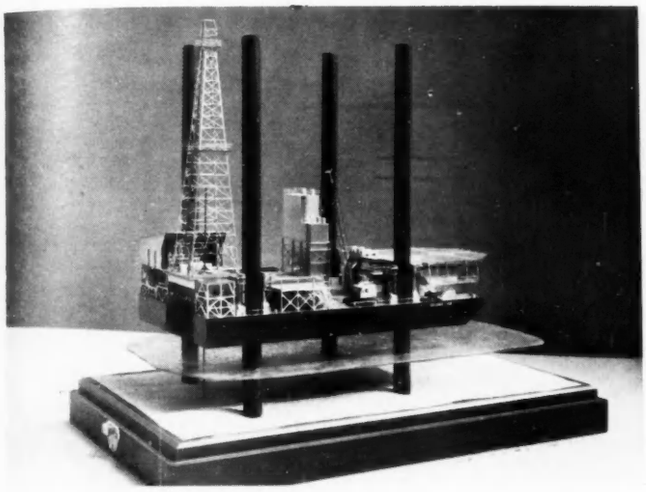
During the period of practical work, the student can work on the subject in which he is particularly interested, in a laboratory, or on the site of a large hydraulic undertaking, or by individual study. In the final term, the course is rounded off, projects are completed, reports on the completed work are drawn up, and students have the opportunity to exchange experiences. A test can be taken by those students wishing to obtain the Diploma of the International Course in Hydraulic Engineering.

Detailed information on the 1958-1959 course may be obtained from the Registrar, International Course in Hydraulic Engineering, Netherlands Universities Foundation for International Co-Operation (NUFFIC), 27 Molenstraat, The Hague, Netherlands.

Construction

MOBILE OIL DRILLING PLATFORM

First to be Built in Britain



Model of DeLong mobile oil drilling platform, showing the retractable legs, which can be extended to the sea bed when the operating location is reached, and the helicopter platform.

The hull under construction at Steel Structures' yard, Southampton.

The first mobile oil drilling platform to be manufactured in the United Kingdom is now taking shape in the Southampton yard of Steel Structures Limited, of the Howard group of companies. The platform, which represents a million pound contract, part payable in dollars, is being made for the DeLong Corporation of America. It is scheduled for delivery to the Shell Company in August for off-shore drilling operations on the coast of Borneo. To get there, the platform will be towed at the rate of about 100 miles a day for from 4½ to 5 months.

The basic principle of this type of platform is that it can be raised and lowered on four retractable legs operated by hydraulic jacks. It can be applied to set up any platform in water and has been used by the DeLong Corporation in constructing jetties, harbour works, bridges, as base for a lighthouse, for anti-aircraft gun platforms and as the foundation for waterside buildings. There is a space in the oil-drilling platform between the two rear legs for the operation of the derrick and drilling rig. When the drill is in use, the platform is raised clear of the water. When required to move to a different position the hull is lowered into the sea, the legs retracted and the platform towed away. One of the illustrations depicts a model of the platform which was exhibited at the recent Conversazione of the Institution of Civil Engineers.

The platform is 190 ft long by 106 ft wide by 16 ft deep and its overall weight when fitted out will be around 4,500 tons. It will be completely self-contained with air-conditioned accommodation for a drilling crew of 30 men. It will have its own generators, boring rig, and mud hoppers and will be capable of drilling down to 15,000 ft below the sea bed. Over the bows is a helicopter landing platform which will provide the link with the supply base when the platform is on drilling location.

The yard in which the platform has been built was opened at the end of last year and construction work began in January. One problem was to obtain the 3,000 tons of steel plates needed. Such a quantity of steel could not be supplied by British steel workers at that time and the order had to be placed in Germany. (The supply position has now improved and any future platforms could be built with British steel.) The preparation of the plates and the building of the caissons, or legs, was all carried out on the site, an automatic edge-preparation machine having been installed to cut the 8 ft wide plates. Every joint on the platform has been welded. The biggest headache in the yard was the problem of handling heavy and bulky units such as the hull plates, which are welded into panels weighing 10 tons. The caissons were made in 40 ft lengths of 10 ft diameter, each weighing 40 tons. Three of these units have to be assembled to make each of the four legs. Other units will be stowed on deck until the platform reaches the drilling area, when they will be welded on to the legs extending each by another 80 ft. The second illustration shows work in progress on the hull.

As much as possible of the fitting out of the hull is being carried out before launching. The major items are the three Paxman 350 kW diesel engines which provide the platform's main power supplies, the air-conditioning equipment, and the hydraulic machinery for operating the jacks. In addition the crew quarters, galleys, store rooms and other amenities have all to be installed. Technical advice and supervision from a handful of DeLong representatives, experienced in this type of construction, has been available throughout the construction period.

Drilling for oil under the sea is a relatively new operation, the possibilities of which were not really investigated until after the war. The method has been most fully exploited in the Gulf of Mexico, and in Lake Maracaibo. So far DeLong have manufactured two mobile oil drilling platforms in Europe, both made by a consortium of German firms at Bremershaven. The fact that they have chosen a British firm to make the third European-built platform reflects two sets of factors. First the British bid was highly competitive and contract time was six weeks better than the German. The DeLong representatives at Southampton say that the quality and speed of the work there compares very favourably with that at Bremershaven. Secondly, it would seem unlikely that an American company, with the world-wide connections that DeLong's have, would enter into arrangements for building one platform here if there was no prospect of further orders from the European oil companies. The expectations are therefore that the present platform should be the first of several. If this proves to be the case, it will be due in no small measure to the skill and hard work of the builder's staff and the two hundred or so men employed on this pioneer engineering contract.

CATHODIC PROTECTION OF BURIED STRUCTURES

Recent progress made in the work of the Joint Committee for the Co-ordination of the Cathodic Protection of Buried Structures is described in a pamphlet dated December, 1957, but which has just become available. In addition to a glossary and lists of references and of the members of the Joint Committee, the pamphlet contains four chapters, headed "Summary of Electrochemical Principles"; "Applications of Cathodic Protection"; "Interference;" and "Research."

In recent years the considerable growth of interest in the use of cathodic protection has brought in new complications, since schemes of this kind operate by setting up electric currents in the soil and these currents are liable to stray to adjacent metallic objects, thereby influencing for better or worse the electrochemical environments of the latter. The Joint Committee constitutes a conference of the principal operators (mainly public-utility organisations) of extensive underground services; it was formed in December 1953. The main object of the Joint Committee is that of examining the possibility of harmful interference caused by cathodic protection systems and of how far it might be desirable to regulate the use of this technique.

A Technical Panel has been set up to handle the detailed affairs of the Joint Committee, and as a result of their work three publications have been issued, dealing, respectively, with recommendations on testing methods (No. 1), the procedure for exchanging information regarding cathodic protection schemes (No. 2) and the problems arising where power cables are to be bonded to other structures (No. 3). Moreover the need has been realised for agreed criteria by which it could be determined whether potential changes on structures near a cathodic protection installation are acceptable, or whether bonding or other remedial action is necessary.

Owing to the lack of complete information concerning the effects of potential or corrosion rates and other matters, it has not yet been possible to make a firm recommendation on permissible values, but provisional working

Continuing Construction

figures have been agreed to by the bodies concerned. To obtain data on this question research has been undertaken at the University of Cambridge and the present position is dealt with briefly in the recently-issued pamphlet.

An important ancillary duty performed by the Technical Panel is the maintenance of a register of known cathodic-protection installations. Details are available of some 500 of these, in which the protected structures range from small-diameter lead-covered cables to 48-in diameter water pipes.

The secretary of the Joint Committee is Mr. J. H. Gosden, B.Sc., A.M.I.E.E., Central Electricity Generating Board, 24-30 Holborn, London, E.C.1.

DISPERSING DETERGENT FOAM

The application of a heavy spray of water has been found to be an economical way of dispersing detergent foam at sewage works, particularly small ones. The following equipment has been designed and installed at the Cadishead Sewage Works, Irlam U.D.C. (near Manchester). The average flow to this works, including surface water, is about 90,000 gallons a day.

A system of horizontal pipes has been laid over the area of the beds with, at intervals, associated T-pieces supporting spray heads. Various sprays were tried but the most effective was found to be that illustrated; it comprises an ordinary copper ball float drilled with a number of small holes. The spray heads are mounted some 4 ft 6 in above the top surface of

Spray head at Cadishead Sewage Works, Irlam

the effluent and have been found to give a heavy spray over a circle of about 25 ft diameter. Water for the spray is drawn from the clear effluent at the end of the beds and is pumped by a standard Pegson-Marlow 3 in centrifugal self-priming pump. A few minutes of operation is found to be sufficient to clear the beds.

Engineering at Home

SHAPING DIAMOND AND SAPPHIRE

Sapphire and diamond styli have largely replaced steel gramophone needles: they weigh less and cause less wear. An effective mass as low as 3 mg may be achieved at the stylus point, and this enables a better frequency response from the pick-up. Sapphire and diamond styli are made at the Philips diamond die factory at Valkenswaard; an account of the processes used is given in *Philips Technical Review*, No. 11, vol. 19. A sapphire stylus is easier to manufacture than a diamond one; but the latter may have a life more than twenty times that of the former. For both materials the initial procedure is similar: a small cylinder is cut out of the bulk material and a cone is ground on one end. The radius of the stylus tip is an important parameter and different methods of producing it are required for the two materials.

Sapphire cylinders 3 mm long and with 0·4 mm diameter are cut from sheets of synthetic sapphire and mounted in small rotating heads by means of shellac. A number of such heads are placed at angle of 22½° to an equal number of high-speed cast-iron grinding wheels. The pores of the wheels contain a little diamond dust in oil. Before the cone is sharp pointed, the grinding is stopped; the procedure is repeated for the other end; and the cylinder is broken in two, ground to 1 mm length, and cleaned. To radius the tips, large numbers of the styli are put into a bottle containing diamond dust in oil. After several days' vibration, the tips of the cones become rounded, radius being controlled by the vibration time. Microgroove records require a radius of 25 microns; 78 r.p.m. records require 75 microns.

For diamond styli, selected stones are first cut parallel to the 111 plane to give plates 1·6 mm thick. From these plates, cylinders 0·3 mm in diameter are cut by means of thin-walled nickel tubes rotating at about 10,000 r.p.m., containing diamond dust in oil. The points on the finished styli are thus in the 111 plane. This plane is chosen partly for its wear resistance and also because 111 faces of reasonable area can be cut from the natural crystal without too much wastage. A cone is cut on the end of the cylinder in the same way as for the sapphire, but the process takes ten times as long. Then, because of the increased hardness and decreased mass of the diamond, the radiusing has to be carried out by hand on a grinding wheel.

Both sapphire and diamond styli are mounted in aluminium bushings in a stylus arm by the same technique.

CHEAPER METER READING

Two devices designed to overcome the problems of electric meter reading were exhibited by Ferranti Limited, Hollinwood, Lancashire, at the recent British Electrical Power Convention. The first is a house service meter with a repeater dial that can be read from outside the house. It eliminates the financial loss occurring when meter readers call on unoccupied houses.

A standard Ferranti household meter is installed inside the house. The repeater, a solenoid operated cyclometer in a hermetically sealed case, is also fixed inside, but with the dial visible from the outside. Where a comparatively large hole cannot be made through the wall, the repeater can be fixed on the outside wall face, a small hole being necessary to carry the leads. A repeater mounted inside the wall has a diameter of $1\frac{11}{16}$ in, and is 11 in long. For mounting on the wall face, it is $5\frac{1}{4}$ in long.

The repeaters are Post Office message recorders operated by impulses transmitted from contacts fitted to the house service meters. For operating the impulsing mechanism, the supply may be taken direct from the 240 V mains. If, however, a low voltage connection between the meter and the repeater is required, an alternative 12 V direct current supply can be obtained from a transformer and rectifier unit housed in a meter case installed near the originating meter.

The second device is the Ferranti billing meter. In operation, the consumer inserts a card supplied by the Electricity Board into a slot provided in the meter. A handle is turned and, on withdrawal, the card bears a printed record of the kWh registered to date. The card is then posted back to the supply authority. For outlying districts, the billing meter will eliminate the high costs of regularly calling meter readers.

Basically, the printing mechanism consists of a spring driven cylometer with rollers having raised digits on the periphery. As the meter kWh register advances, it releases the drive from the spring through the medium of a dead centre escapement, so that the printing rollers are maintained in step with the reading shown on the meter dials. The spring providing the drive is wound by the printing handle, which thus carries out the two operations of printing and winding at the same time. The meter exhibited printed the figures by means of carbon paper, but various other methods are practicable.

REFRIGERATOR SALES WARM UP

There is an old saying about selling refrigerators to Eskimos. That problem might not be easily solved, but there is little doubt about the solution of selling refrigerators to Britons, as the latest figures from the Electricity Council show. The Area Boards alone sold 12,845 refrigerators during May—an increase of 182·9 per cent over May, 1957. The reason? Well, for one thing, the purchase tax was reduced in April. To be fair, that reduction cannot be held wholly responsible, as the total sales of refrigerators for the twelve months ended 31 May, 1958, were also up on the previous twelve months by no less than 82·5 per cent.

Britain still has a long way to go in the use of refrigerators to catch up with some other countries. Statistics quoted by Mr. J. I. Bernard at the recent British Electrical Power Convention show that only 10 per cent of all households in Britain had refrigerators, while the figure for the United States was no less than 94 per cent. In between were Canada (84), Australia (71), Germany (18) and France (12). There would still seem to be room for a few more in Europe, without the market becoming saturated.

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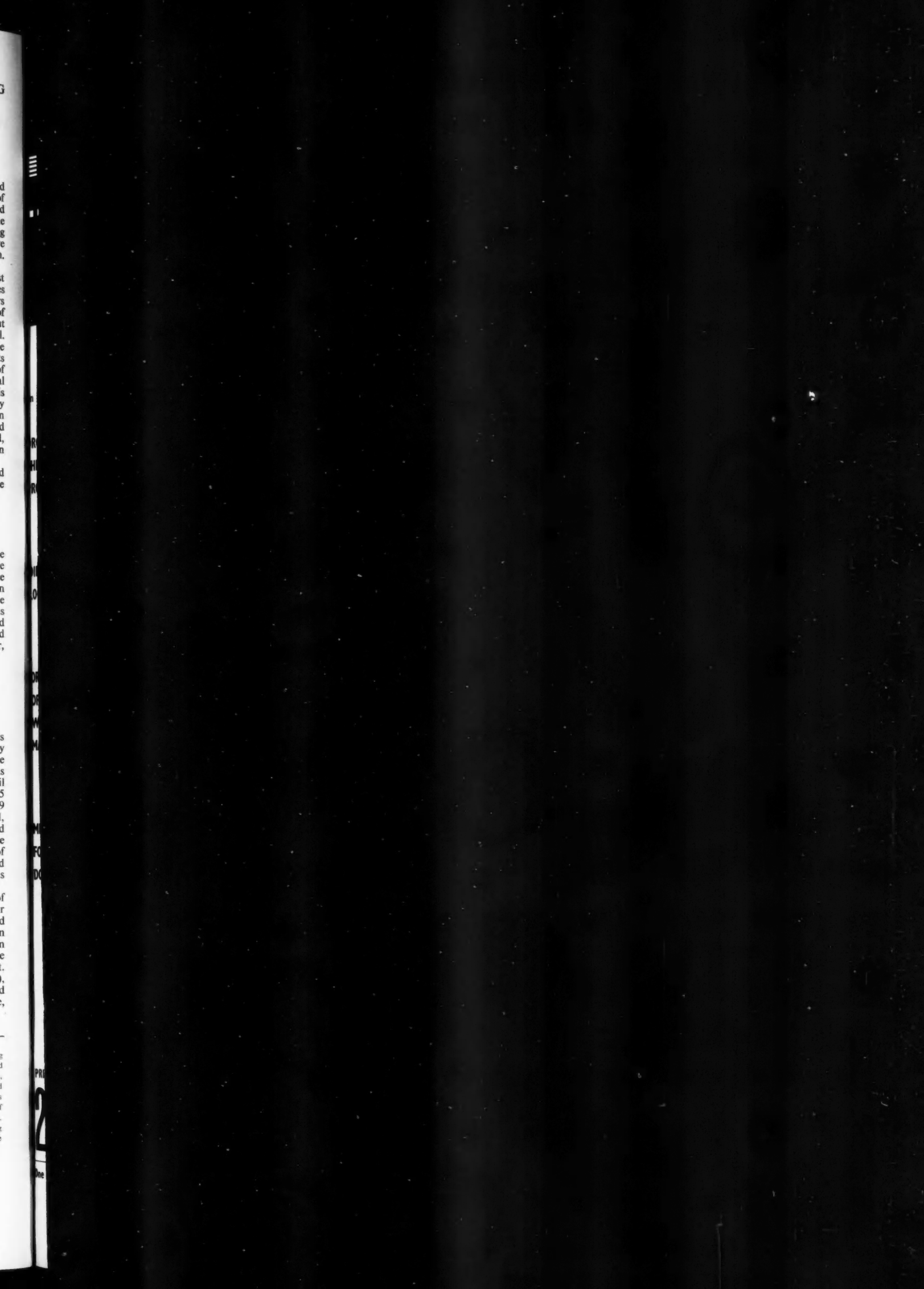
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